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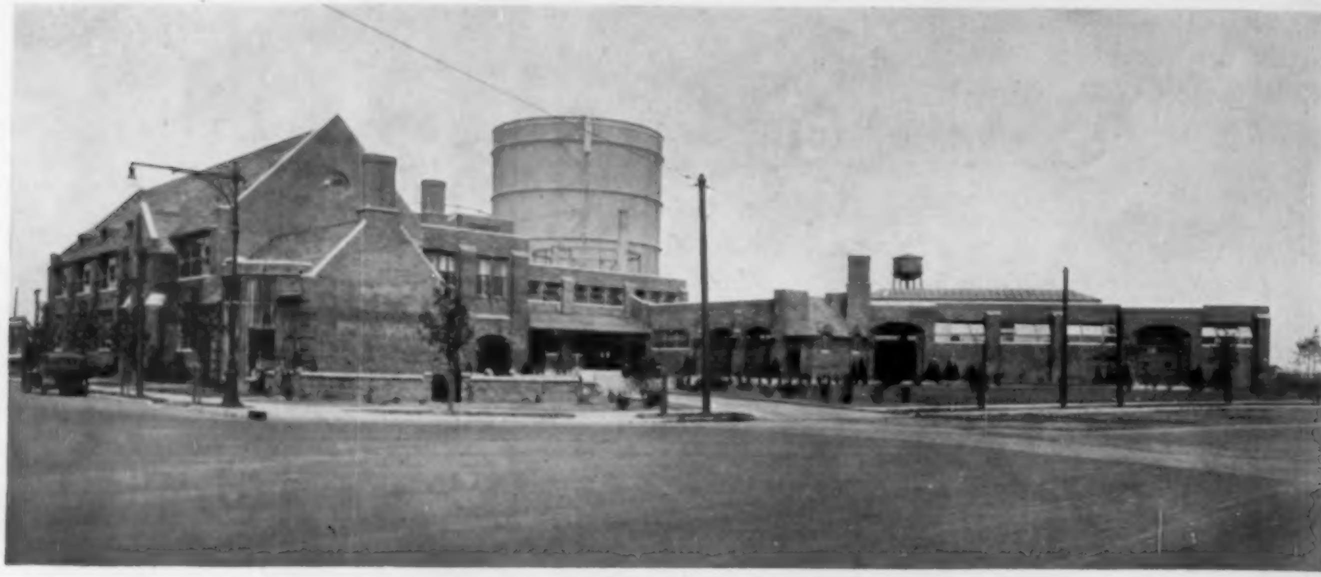
OCTOBER 1931

Our 5th Contract for Brooklyn Boro Gas Co.



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Contract covered complete foundation work including MacArthur Piles, footings and foundation walls.

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1913
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1913
Office Building, Pedestal Type Piles.

1927
Waterless Gas Holder (see illustration — left center) Pedestal-Tension Piles.

1929
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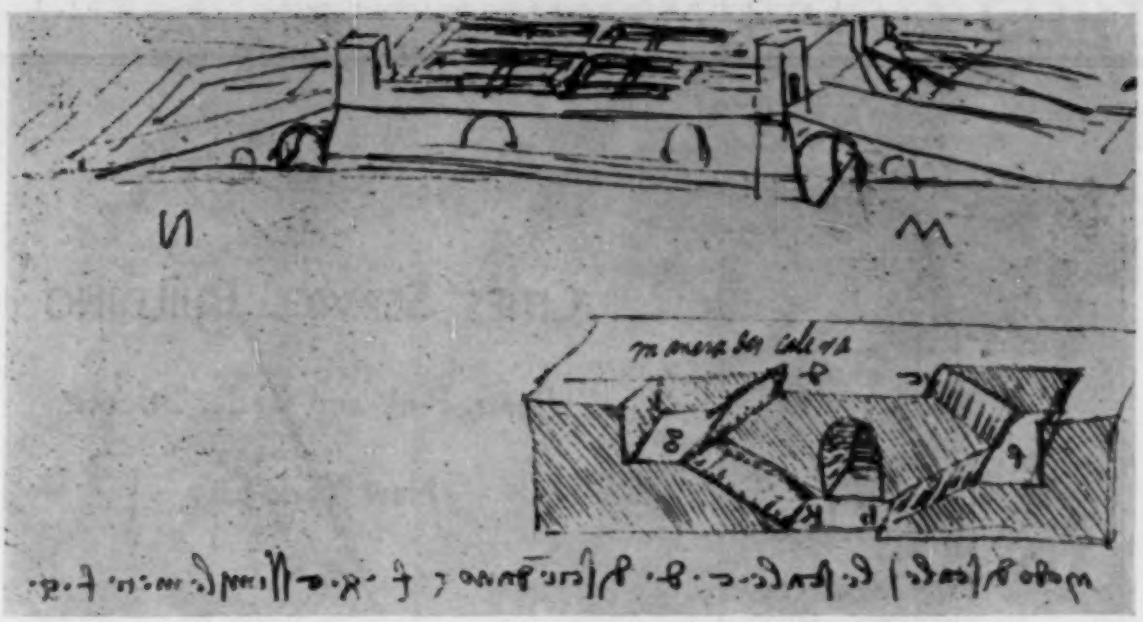


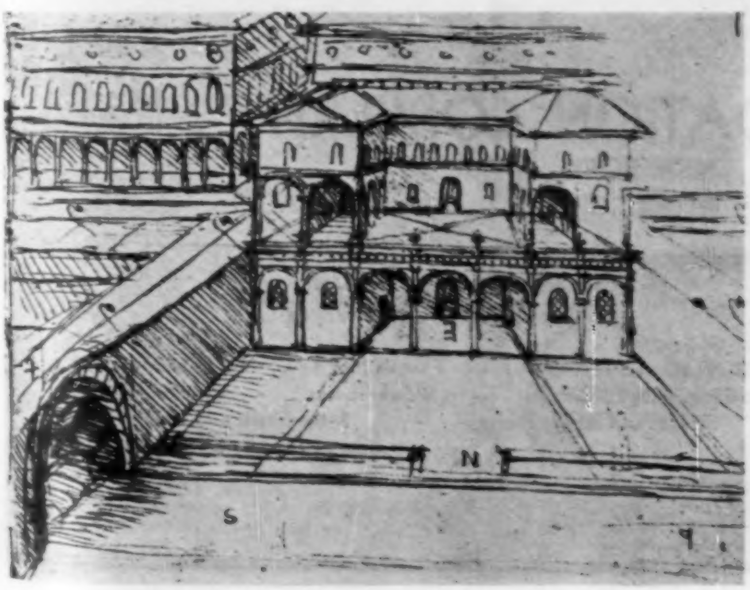
Sketches from *The Literary Works of Leonardo da Vinci*, by J. P. Richter, 1883

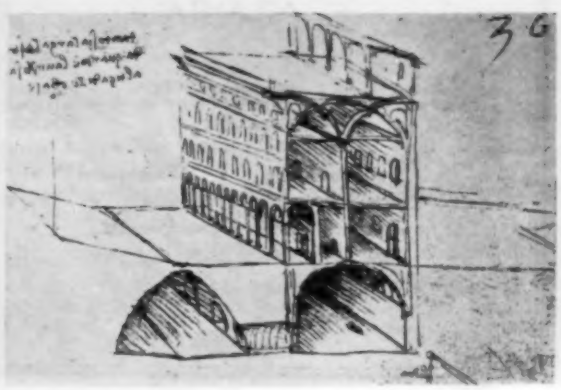
L Da Vinci 1507

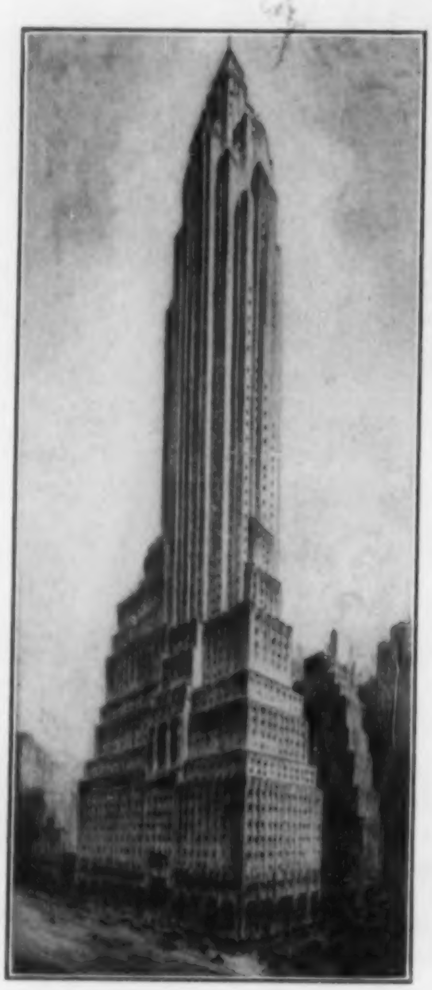
City Plans of a Great Man

LEONARDO DA VINCI was a painter, sculptor, architect, engineer, musician, and natural philosopher. His great versatility as well as his unique genius still arouse admiration and wonder. His drawings and writings were done with his left hand, and his handwriting, curiously enough, was usually executed in reverse, from right to left, as can be seen in these examples. However, he probably painted with his right hand.

These sketches are reproduced from his notebooks, which cover a period of 40 years. They depict the layout of a town with a double system of high-level and low-level roadways, and plans for a hygienic city with underground avenues flushed by canals. The houses are limited in height to the width of the street. "People should not be packed together like goats and pollute the air for one another," Leonardo wrote.







Among Our Writers

John C. Hoyt, a Cornell graduate, has been with the Water Resources Branch of the U.S. Geological Survey since 1902, almost from the inception of this service. From 1911 until the current year, he was Hydraulic Engineer in charge of surface waters. At present he supervises the technic of this branch in Washington and in the field offices.

John R. Slattery, a graduate of the U.S. Military Academy at West Point, served in the Army until 1925, largely in connection with river and harbor improvements. He was identified with harbor work at New York; at Honolulu and Hilo, Hawaii; and at Jacksonville, Fla. He was also connected with the work of the Third Mississippi River District and that on the lower Columbia River at Portland. He left the military service to take up his present duties for the New York Board of Transportation.

Alonzo J. Hammond during a long professional career has directed the design and construction of many million dollars worth of engineering works, consisting of municipal, railroad, bridge, hydro-electric power, and water supply projects. He designed and built several of Chicago's movable bridges. As Consulting Engineer and Assistant Chief Engineer of the Chicago Union Station Company, he spent seven years planning and building the $75,000,000 terminal which serves the Pennsylvania, the Burlington, the Alton, and the Milwaukee lines. He now maintains consulting offices in Chicago.

C. E. Grunsky, a Past-President of the Society, in the course of a long and varied experience, has served as Assistant State Engineer of California, as a member of the San Francisco Sewerage Commission, as City Engineer of San Francisco, as a member of the Isthmian Canal Commission, and as Consulting Engineer for the U.S. Reclamation Service. Since 1910 he has been senior member of the C. E. Grunsky Company, Consulting Engineers.

Carl B. Andrews was born on the Island of Hawaii, and except for short intervals has spent his entire life in the Hawaiian and Philippine Islands. For ten years he was Chief Engineer of the Oahu Railway and Land Company, Honolulu. During 1930 he built in the Philippines a 1,200-ton sugar mill, with its rail and wharf facilities. On his return to Hawaii, he accepted the chair of engineering at the University of Hawaii, Honolulu, which position he still holds.

F. E. Emery, early in his career, specialized in the design and construction of bridges and structures. For four years, he was overseas with the Canadian Expeditionary Forces. On his return he had charge of the Calgary sales office of the Manitoba Bridge and Iron Works until 1925. Later he became connected with the Structural Clay Tile Association, with headquarters in Cleveland. Nearly two years ago he was transferred to the New York office as Secretary and Engineer of the Eastern Manufacturers Group of the Association.

H. A. Shuptrine has served since 1919 as Bridge Engineer for the Board of Wayne County Road Commissioners. In this capacity he designed and supervised the building of two $1,000,000 bascule bridges of the double-leaf turnover type over the Rouge River at Detroit. These required the construction of heavy and difficult pneumatic cofferdams, which extended 80 ft. below water level.

Donald M. Baker, a consulting engineer of Los Angeles, specializes in water supply and in city planning. He has been actively identified for a long time with the movement for the registration of professional engineers in California and was the first president of the California Engineers Registration Association.

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Volume 1 October 1931 Number 13

National Aspects of the Drought

U.S. Geological Survey Figures Reveal Engineering Significance of Conditions Past and Present

By John C. Hoyt
Member American Society of Civil Engineers
Hydraulic Engineer, U.S. Geological Survey, Washington, D.C.

Now that statistics for the drought of 1930 are available on a country-wide basis, engineers may view this period in terms of facts rather than general opinions. As most of the effects of interest to engineers are continuing during the present year, this article is of more than historical interest. The facts were gathered through reports on stream flow from the 33 district offices of the United States Geological Survey, rainfall reports from the United States Weather Bureau, and miscellaneous information from other sources. From the standpoint of authorship no less than of sources of information, this treatment deserves the status of outstanding authority on a vital national problem.

For engineers, the problems that have been brought into prominence by the drought of 1930 are just beginning. First there is the aftermath. Inasmuch as groundwaters are depleted, both surface and groundwater supplies will be scanty during 1931 in many regions, and unless there are exceptional rains, some communities will face a water shortage comparable to that of last year.

Beyond this, there is the long-time problem of planning for the next drought, which sooner or later is sure to come. It is essential that the experience gained during the past year and that to be gained during the present year should be focused upon the problem while the effects are fresh in the public mind, to the end that future water supplies may be made adequate to meet another such emergency.

In two ways the drought of 1930 has been of especial significance to engineers—it has revealed new facts about the basic problems of water supply and, as the severest occurrence of its kind on record, it is likely to stand for some years as a low point upon which future estimates of supply will be computed.

Basic Causes Unknown

In outlining what the drought has taught, it is significant to point out how much remains to be learned. Not even the fundamental cause has been established. It is known that for a time there was a series of high-pressure areas scattered across the country and that low pressures did not develop in the atmosphere to bring rain. Later, when the drought had broken in some regions, a stationary "high" over the Rocky Mountain and Great Basin areas forced the "lows" north or south, or up the Mississippi Valley, so that rainfall was diverted from a wide belt east of the Mississippi.

This abnormal condition, according to a recent report by the United States Weather Bureau, was due to the fact that cold air from the Arctic regions did not come southward, as in normal years, to cool the air and facilitate precipitation. But what caused this failure is yet to be determined. Weather Bureau officials are unanimously agreed that sun spots were not the cause.

Estimates on an Empirical Basis

Until a cause is established, it will not be possible to predict rainfall even for one year in advance. This places the science of water supply estimates on a purely empirical basis. Under present knowledge, engineers may view the recurrence of droughts as somewhat similar to the drawing of cards from a deck. An exceptionally dry year may occur with somewhat the same frequency as an exceptionally bad bridge hand, but an estimate of the average period of recurrence can be based only on observations and not on mathematical probabilities. No definite law of recurrence has been established. Studies of tree rings have been carried back for centuries in some regions without definitely revealing a repeating cycle.

It is certain, however, that a drought as severe as that of 1930 can happen again, because four other droughts in the past 50 years were comparable in extent, deficiency of rainfall, and continued heat. The drought of 1930 surpassed these only in duration. They occurred in 1881, 1894, 1895, and 1910. The juxtaposition of the two dry years of 1894 and 1895 carries its own warning. The fact that we cannot predict the year of the next major drought is added reason why immediate steps should be taken to insure water supplies against the conditions of 1930.

The drought of 1930 has received more attention than past dry spells not only because of its coincidence with an economic depression, with attendant political and relief problems, but also for the more basic reason that the demand and uses for water have increased vastly even since 1910. The broadening field of activities affected by the drought of 1930 is discussed under drought damage.

Before touching on the lessons that will be needed in coping with these human elements, a brief review of what happened in terms of rainfall and run-off is pertinent.

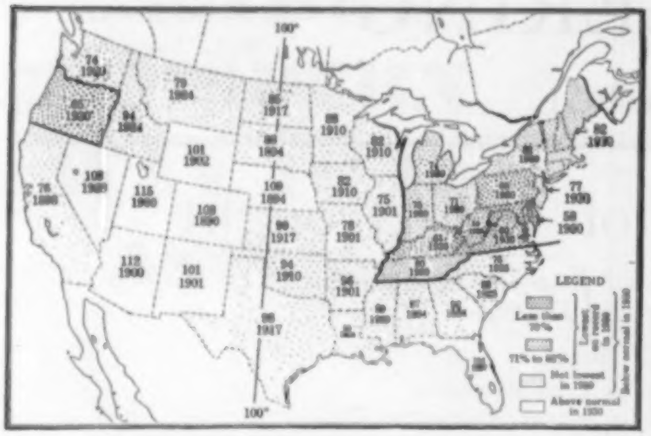


FIG. 1. PRECIPITATION IN 1930
In Percentage of Mean for Period of Record, Also Year of Lowest Average Precipitation

In 1930 rainfall was deficient in 40 states, in 19 of which previous minimum annual records were broken. Even more records were broken on a basis of single months or groups of months. In 1930, 55.9 per cent of the area of the non-arid states had deficient precipitation, as compared with 54.3 per cent in 1894, 44.5 per cent in 1895, and 50.4 per cent in 1910. This comparison shows that 1930 was slightly drier than any other year in the period of record. It was much worse, however, in its longer duration of dry weather and excessive heat.

The rainfall in 1930 in each state is indicated in Fig. 1. The bar graph, Fig. 2, is offered as an example to show how rainfall varies over long periods. It is for Virginia, one of the states most severely affected by the drought of 1930.

The severity of the heat accompanying the drought is indicated in Fig. 3, which gives for each state the maximum temperature and the number of days in which the temperature rose to 100 deg. fahr. or higher.

RUN-OFF RECORDS VALUABLE

When records of run-off are available for a sufficiently long period to permit the computation of means that can stand as normals, such records provide a better possibility of studying and comparing droughts than records of rainfall. To give an idea of what has happened, Table I, showing deficiency for the Potomac River at Point of Rocks, Md., is offered as a typical example. The Potomac above this station has a drainage area of 9,650 sq. miles and is in the area that was most affected by the drought. Although a record low flow was not made in 1930, the duration of extremely low discharge beyond that of any other year may be noted at a glance. This condition holds good for many other streams, whether or not record minima were reached.

The mean flow of the Potomac River for the water years 1897 to 1930 was 9,580 sec-ft. The mean flow for the ten months from May 1930, to February 1931, was 1,658 sec-ft. Prior to 1930 there were only two months when the mean flow was below 1,000 sec-ft.—September 1925, when it was 952 sec-ft.; and November 1922, when it was 989. During the calendar year 1930 the mean flow was below 1,000 sec-ft. for four consecutive months —August, 771 sec-ft.; September, 834; October, 706; and November, 911.

Scientific observations of groundwater conditions in 1930 are scanty, but all levels observed in the drought area, together with reports that many springs and wells failed for the first time on record, establish beyond question the fact that groundwaters were seriously depleted in 1930 and will probably remain so throughout 1931.

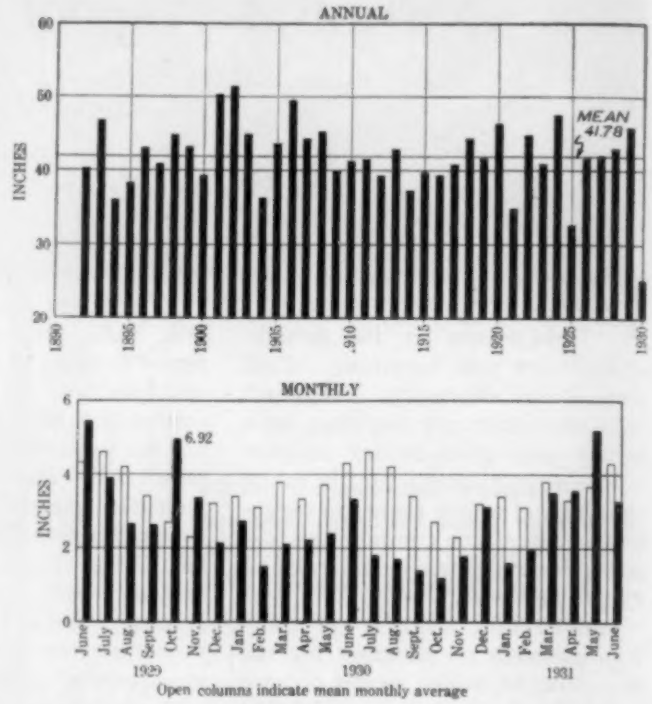


FIG. 2. ANNUAL AND MONTHLY PRECIPITATION IN VIRGINIA

As summer stream flow depends largely upon groundwater, serious shortages in water supply are occurring during 1931, for reasons that will be explained more fully later in this article.

The drought of 1930 greatly interfered with many activities, and the resulting losses were greater than those sustained during any previous similar experience. The damages and losses due to a drought are determined by the extent of its interference with normal activities and are indicated by the effect on vegetation, principally agricultural crops; on water supplies as related to domestic, industrial, and recreational uses; and on power, irrigation, navigation, and health.

Therefore, in determining the damage done by a drought in a given area, many factors must be considered. Among these are the character and extent of agricultural and other activities in the area, climatic conditions, geology, topography, and facilities for the conservation and storage of water. The whole question is so complex that it is difficult to compare the damages of droughts that occur in different areas or in different years; and any comparative statements relative to damages should be made only for areas with definite limits, where the various conditions are similar. A drought in a particular locality may be detrimental to vegetation and not to water supply, or vice versa.

Although, as far as engineering design is concerned, a drought is purely a local problem, there are national features that enter the broader economic phases of professional engineering. It is to be remembered that drought effects tend to vary widely, owing to uneven distribution of rainfall and run-off and to the variable susceptibility of different areas to drought damage. Nevertheless, a general summary of national effects may be given.

DROUGHT DAMAGE

To agricultural engineers and economists, the drought of 1930 opens a wide field for observation and research. The principal crop damage occurred in a belt of states

TABLE I. DEFICIENCY TABLE FOR POTOMAC RIVER (DRAINAGE AREA 9,650 SQ. MILES) AT POINT OF ROCKS, MD.

(In Terms of Number of Days Discharge Fell Below Designated Flow)

Sec-Ft. Calendar Year	500	550	610	700	800	1,000	1,300	1,600	2,000	2,500	3,100	3,800
1897	..	..	..	..	..	..	..	9	29	73	107	137
1898	..	..	..	..	..	..	..	6	8	46	71	95
1899	..	..	..	..	..	..	..	23	50	115	152	172
1900	..	..	..	..	..	..	39	101	110	129	152	173
1901	..	..	..	..	..	..	..	..	2	15	60	88
1902	..	..	..	..	..	..	12	25	51	97	124	162
1903	..	..	..	..	..	..	..	..	52	60	86	113
1904	..	..	..	..	..	6	58	86	107	132	150	196
1905	..	..	..	..	..	..	..	..	14	37	62	130
1906	..	..	..	..	..	..	..	..	..	..	17	59
1907	..	..	..	..	..	..	..	..	..	2	15	57
1908	..	..	..	..	..	..	..	5	15	58	110	150
1909	..	..	..	..	..	..	..	25	112	132	163	178
1910	..	..	..	..	..	1	7	64	121	147	175	198
1911	..	..	..	1	1	1	16	24	40	51	83	109
1912	..	..	..	..	..	..	..	..	8	42	91	121
1913	..	..	..	..	1	1	4	17	29	42	69	107
1914	..	1	1	4	12	28	63	83	110	133	166	191
1915	..	..	..	..	..	..	1	3	6	22	72	99
1916	..	..	..	..	..	2	13	30	65	92	134	148
1917	..	..	..	1	2	6	24	45	67	94	126	167
1918	..	..	..	..	..	..	6	15	27	47	144	183
1919	..	..	..	..	..	..	9	26	48	59	87	113
1920	..	..	..	..	..	..	..	4	33	45	75	94
1921	..	..	..	..	..	..	6	25	47	64	96	116
1922	..	..	..	..	3	43	67	78	110	131	156	182
1923	..	..	..	1	12	23	38	68	102	121	153	178
1924	..	..	..	..	..	..	..	3	17	32	78	108
1925	..	..	..	..	..	21	42	63	89	111	159	182
1926	..	..	..	..	..	..	..	7	20	43	94	127
1927	..	..	..	..	..	5	15	32	39	48	82	107
1928	..	..	..	..	..	..	..	6	25	47	64	93
1929	..	..	..	..	..	..	16	40	62	77	85	102
1930	..	..	1	18	72	138	161	177	198	208	225	236
1931 (Jan. 1–May 16)				..	..	..	..	6	20	29	48	62

running northward up the Mississippi Valley and eastward along the Ohio River Valley and on to the Atlantic seaboard. The local effects were spotty, varying sharply even between adjacent counties as affected by the chance passage of local storms and by the ability of the soil to hold moisture.

In general, however, there seems to have been a more or less direct correlation between rainfall and crop yields. In Fig. 4 are given Department of Agriculture figures for the percentage of normal crop yield in each of the 36 non-arid states as compared with the total rainfall for June, July, and August 1930. It is shown that in all but one state, whose crop yield was normal or above, the total rainfall for the growing season was more than $8^1/_2$ in., whereas the most serious damage to crops occurred in the states where the rainfall fell below 7 in.

Heat as well as shortage of rainfall was a contributing factor to crop damage. During hot nights, with no dew, moisture from the air was totally lacking, and crops withered in the daytime. Grass and forage crops suffered similarly. This deficiency, with the failure of wells and surface supplies used for watering animals, caused a serious problem in some livestock areas.

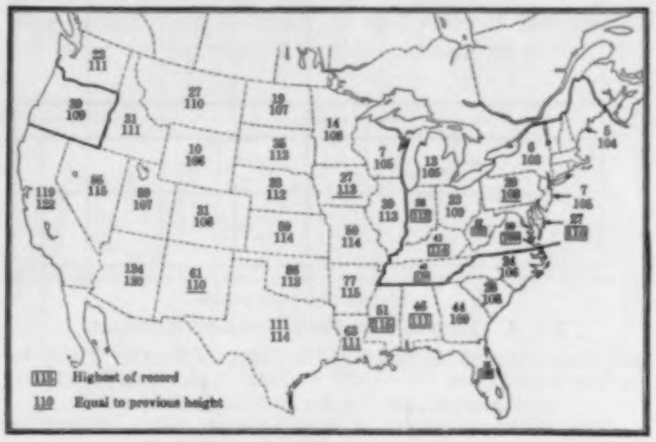


FIG. 3. TEMPERATURE DURATION

Number of Days in 1930 with Maximum Temperature of 100 Deg. or Higher, and Maximum Temperatures in July and August 1930

Trees suffered to some extent. It was found that woods on hillsides, where the trees had built up resistance to lack of water or had developed deep roots, came through with relatively small damage. Many trees in lowlands that were normally moist died after their usual supply of moisture had receded. Certain insects multiplied through the drought.

The net effect of all agricultural damage was not to produce any general food shortage but simply to embarrass the farmers most affected, especially those raising cash crops, the failure of which left many who were working on a scant margin utterly without means of support. The heavy relief and farm loan burden that ensued, requiring more than $80,000,000 in Federal and Red Cross funds, is only a partial measure of the economic loss occasioned by the drought. The peak of the drought relief aid by the American Red Cross was reached the last of February 1931, when assistance was being given to 460,240 families, aggregating 2,000,000 persons in 850 counties in 22 states.

The remedy of sustenance gardens on farms that formerly raised only cash crops may be considered one of the most powerful forces now acting toward economic readjustment in some areas, due directly to lessons learned in the drought of 1930.

The effects of the drought on irrigation may be found only in the non-arid states, which are mostly east of the 100th meridian. As most water supplies in the irrigated West are dependent more upon melting snow in the high mountains than upon rainfall, the drought of 1930 affected irrigated crops through abnormal heat rather than through water shortage. Even so, there was a net loss of 652,554 acre-ft. in 21 reservoirs of the United States Bureau of Reclamation, representing a total capacity of 10,814,500 acre-ft. In 8 of the reservoirs there was a net gain of 153,957 acre-ft., but this was offset by a loss of 806,211 acre-ft. in the 13 others.

Low stream flow and low groundwater levels seriously

affected water supplies dependent upon natural stream flow or shallow wells. Most of the water sources supplied from adequate storage or from deep wells tapping water-bearing formations were ample for usual activities. Many communities lacking such supplies found it necessary to ration water, drill new wells, lay emergency pipe lines, build temporary dams, or resort to water haulage.

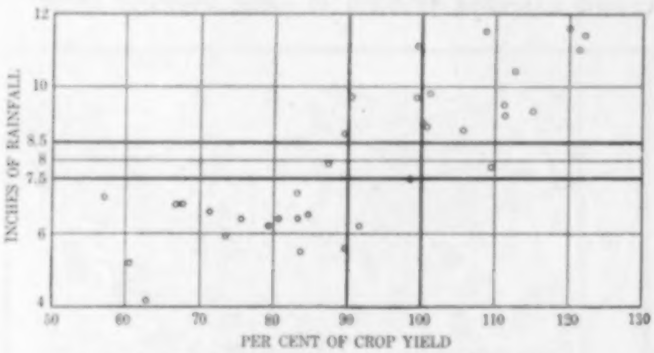


FIG. 4. RELATION OF CROP YIELD TO RAINFALL

1930 Yield per Acre Expressed as Percentage of Average Yields for the Ten-Year Period 1919–1928, to Total Rainfall in June, July, and August 1930, for the 36 Non-Arid States

Many industries were handicapped by inadequacy of water for processes or disposal of waste. Municipal sewage disposal also was a problem, owing either to complete failure of the water supplies ordinarily used for disposal or to insufficiency of the supplies for the usual dilution without intensive treatment.

The danger of pollution led to heavy chemical dosage at many filtration plants. Furthermore, many water supplies were of unusual hardness, owing to the fact that the stream flow was derived mainly from deeper groundwater than usual, such water having normally a higher mineral content than nearby surface waters. This condition necessitated the modification of treatment processes in many plants and led to scale deposits in heaters and pipe lines where no such trouble had formerly occurred.

Owing to the watchfulness of sanitary engineers, no serious epidemics resulted from the drought. According to a report by the Public Health Service, there was probably some increased mortality from chronic diseases and from the common respiratory diseases. During the fall of 1930, the report states, there was an increase in the prevalence of typhoid fever over the low rates for the preceding two years. Some of this increase was attributed to polluted water supplies that resulted from low water. An increase of pellagra in two states in the drought area is further cited.

WATER POWER AND NAVIGATION AFFECTED

The effect on water power production can best be measured by a comparison between the change in total output of electric power by the public utilities between 1929 and 1930 and the corresponding change in water power output, both shown in Table II.

Decline in total output was, of course, due to the economic depression. It is sufficiently obvious, however, that water power would have tended to hold its own if stream flow had been adequate. As it was, the sharp decreases in water power production in most regions stand as an index of the serious economic loss suffered by power utilities. Some large hydro-electric plants were entirely shut down at times during 1930.

TABLE II. OUTPUT OF ELECTRIC POWER IN 1930 AS COMPARED TO THAT IN 1929

Division	Change in Total Output (Per Cent)	Change in Output by Water Power (Per Cent)
New England	− 7	+ 4
Middle Atlantic	− 2	−17
East North Central	− 9	−22
West North Central	+ 1	−16
South Atlantic	−16	−54
East South Central	+ 4	− 1
West South Central	− 9	+ 3

Some trouble was occasioned to steam plants through lack of condenser water and through boiler scale due to the marked increase in hardness of the water. The warmer water caused by high temperatures and low flows also had its effect on steam plant efficiency.

Although the effect of the drought on navigation was not considered highly serious by the Chief of Engineers, it was found necessary to continue dredging in the Mississippi River and its tributaries for a longer period than usual. Heavy drafts were made from the Great Lakes and from reservoirs in the upper Mississippi basin to sustain water levels. At some points it was difficult to maintain pool depths, because of evaporation, leakage, and lockage losses. Special efforts had to be made to prevent leakage at the dams throughout the system.

During the past few years, the use of water for recreation has so greatly increased that it has come to be recognized as a factor in water supply planning. Low water in 1930 interfered with boating, fishing, and bathing, owing both to inadequate supply and to pollution. Some commercial fisheries also suffered, although some sea-coast fisheries benefited somewhat because salt water extended farther inland in tidal estuaries than ever before recorded. Oyster beds, however, were probably damaged by excess salinity from this cause.

1931 CONDITIONS

In general, precipitation during 1931 has been below normal. Its distribution, however, has been especially favorable to crop growth and there has been but little damage except in the Northwest. On the other hand, irrigated sections have used practically all available storage. Indications are that 1931 will be a record low-water year for many streams. The distribution of stream flow has been somewhat better than in 1930, and groundwater conditions have not been far different from those of that year. Decrease in the production of electricity by water power has continued at about the same rate as in 1930.

In order to show why run-off is likely to be short in a year following a major drought, it is necessary to undertake some discussion of the fundamental principles involved. As groundwater is the key factor in run-off during the most critical period of a drought, a clear conception of annual cycles in groundwater storage is essential.

Subsurface water is divided into two zones—a lower zone of complete saturation and an upper zone of aeration, or incomplete saturation. The upper zone is divided into three belts, which separate or merge under varying conditions of moisture. These are the upper belt of soil water, the intermediate belt, and the capillary fringe. The

capillary fringe is just above the water table or groundwater level—that is, the upper surface of water in the zone of saturation.

In the spring, after the frost is out of the ground, water from rains or from thawing ice and snow can penetrate the soil and seep down to the zone of saturation. The groundwater level rises during this recharging period. After the growing season sets in, the downward seepage is retarded by the vegetable cover. As the season advances, most or all of the rain goes into surface run-off, transpiration, or evaporation, without reaching the water table. The groundwater level recedes until after the growing season ends, rarely rising during this period except in times of heavy rainfall. Recharging begins again in late fall, winter, or early spring, according to locality and conditions.

Although in the spring, owing to a temporary saturation of the upper belt, soil water contributes to run-off, summer stream flow, in the absence of rain, is dependent upon groundwater from the lower zone of saturation. The available draft from groundwater diminishes as the level falls and outward pressure is reduced.

The available groundwater supply, however, for most river drainage basins is so great that it is adequate to maintain the stream flow at practically a fixed minimum without appreciable change for a considerable period, and probably through any drought that may be expected. The records of stream flow indicate that there is but little variation in flow during low-water periods, except those caused by surplus precipitation, and after this has reached the stream the flow soon falls to the previous minimum. During 1930, minimum flows for the periods of record were established on many streams as early as July, and the flow did not go much lower as the drought continued.

EVAPORATION AND TRANSPIRATION

Not all of this waning supply is available for run-off, because transpiration through foliage and evaporation from the soil and from surface water demand a heavy share, particularly in dry, hot years. As much as $3^1/_2$ in. of rainfall a month can be consumed in this way. The effect on stream flow of the consumptive use of water by evaporation and transpiration is shown by the graph in Fig. 5. The high peaks are due to rains. The hydrograph for a winter period would approach a straight line, based upon steady draft from groundwater, with peaks only for precipitation or thaws.

In the summer period shown in Fig. 5, the hydrograph resembles a sine curve, fluctuating daily as draft by transpiration and evaporation becomes heavy in the daytime and diminishes at night, with some lag before this effect shows up in stream flow. The curve shows that, after a rain peak has subsided, diurnal fluctuations are resumed on a higher level, which gradually recedes to that represented by a draft from groundwater alone.

The effect of evaporation and transpiration upon small streams and springs may be noted visually. During light rains, which would be insufficient to contribute to surface run-off, stream flow may be seen to increase, owing to a decrease in consumptive use of groundwater. It was observed in 1930 that some dry streams and springs started to run again after the growing season, although there had been no rain to cause this change.

In dry years the effect of evaporation is to make the ratio of run-off to rainfall lower than normal. To overlook this fact in making estimates would tend toward substantial exaggerations in estimating stream flow on the basis of rainfall alone. To cite an example, studies for the combined flow of the Tennessee and Cumberland rivers showed that, for a 30-year average, run-off was 45 per cent of the precipitation. In wet years it ran over 50 per cent; in dry years it ran 35 per cent or under. All

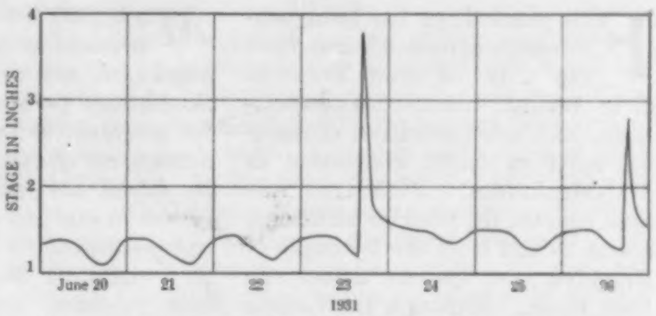


Fig. 5. Consumptive Use of Water by Plant Growth
Fluctuations of Stage in a Small Stream Near Cabin John, Md.

these factors combine to make summer flow extremely low in a drought year or in a year following a drought.

Another condition that was emphasized by the drought of 1930 is the wide variation between unit run-off in different areas, even in adjacent drainage basins. Over long periods, groundwater discharge could be studied directly, without rainfall to obscure the results.

In some places one stream went dry although another steam of comparable size in an adjacent drainage basin delivered a fair flow through the entire drought. This indicates a variety of geologic and other unknown factors for further study and shows the need for actual records of stream flow in each area considered for water supply development, rather than for formulas or observations on nearby drainage basins.

In order that future water supplies may be safeguarded against injurious effects from another drought as great as that of 1930, which is virtually certain to occur in due course, thorough statistical guidance will be necessary as a basis for sound planning. The phenomena of water supplies, which are far from simple in normal years, are even more complex in times of drought. Therefore, the only sure basis is to obtain stream-flow measurements and records of groundwater levels over a long period of time in each drainage basin considered for development. If such figures are collected under a nation-wide plan, they will be useful not only to serve local needs but to develop a more complete understanding of the intricate relationship between rainfall, run-off, and groundwater.

As many of the drought problems which affect the engineering profession have in general continued through 1931, engineers interested in water works planning will have the opportunity to obtain valuable information, which may stand for a long time as marking a low point upon which future estimates can be based. Where streams that seem likely of development are not being studied by national or other agencies, engineers who are able to collect data on run-off may find it to their advantage to obtain all possible information during the present year.

Manhattan's Mid-Town Vehicular Tunnel

Studies Which Dictated Choice of Route and Details of Adjuncts

By John R. Slattery
Member American Society of Civil Engineers
Deputy Chief Engineer, Board of Transportation, New York

Mammoth transportation projects continue to engage the attention of municipal engineers. In Manhattan the highway problem is especially acute for geographical reasons, as the rapid development of districts on either side of the island has brought about great congestion in east and west traffic. Serious emergencies call for major readjustments. As a result, the Mid-Town Tunnel has been proposed, widely discussed, and accepted in principle.

In this article, Colonel Slattery briefly reviews some of the important considerations leading to the choice of the present official plan for the construction of what will be one of the great engineering works of the next few years. The origin of this paper was a talk presented before a recent meeting of the New York (now Metropolitan) Section of the Society.

For years there has been considerable agitation throughout the City of New York—in civic bodies, commercial associations, and administrative circles—for relief of traffic congestion in Mid-Manhattan. With this has been coupled the need for additional access to and from the boroughs of Brooklyn and Queens across the East River. Although the various proposals have differed in detail, they have had much in common. Their essential feature has been a subaqueous vehicular tunnel running east and west under the East River somewhere between 30th and 50th streets, Manhattan. At its Long Island end this tunnel would communicate with the boroughs of Brooklyn and Queens, and in Manhattan with the proposed subsurface route to extend westward across the city. This route would connect the tunnel with the new West Side elevated highway and with some future tunnel to New Jersey.

Of the concrete proposals made, the latest has been prepared by the City's Board of Transportation at the direction of the municipal authorities. The general location of this proposed development is shown in skeleton form in Fig. 1.

Approaches Present a Difficult Problem

Many attempts were made to work out a plan which would provide for approach tunnels from Third Avenue, Manhattan, and still assure rapid and uninterrupted movement in the main tunnel. The function of these approach tunnels was to provide for the ingress and egress of vehicles on the East Side. Two problems presented themselves—one, to design the junction in such a way that vehicles entering or leaving the tunnel by means of the approaches would not cross the path of traffic traveling straight through the main tunnel; the other to insure that vehicles entering by way of the approach tunnels would work into the stream of through vehicles without causing delays in the main tunnel.

Since it is proposed to make the main tunnel a toll tunnel, in competition with free bridges and streets, it is of vital importance to provide for the rapid and uninterrupted movement of traffic through it. However, it soon became apparent that providing two approach tunnels properly arranged for traffic would involve difficult construction as well as the expenditure of large sums of money. In the interest of economy it was accordingly decided to omit these approach tunnels, together with their plazas at 28th and 47th streets.

Studies were next directed toward the working out of a plan whereby vehicles might leave the main tunnel by a single exit and enter it by a single approach without risk of delaying the main stream of traffic. Theoretically this should be possible, but it was concluded that practically it would be impossible when traffic was heavy, because it would demand a knowledge of the destination of vehicles, and a coordination on the part of those directing traffic far beyond what is practicable. This conclusion was based on careful observation of what actually happens in handling traffic.

Results obtained in practice are a much safer guide than theoretical possibilities. Eastbound traffic on the Queensboro Bridge is handled on two bridge approaches which merge. When traffic is heavy, vehicles in both roadways approaching the junction point are repeatedly forced to stop. In fact, traffic in all approach lanes is often seriously delayed, even when movement on the bridge beyond the junction point is relatively free.

Observations lead to the conclusion that in order to move the maximum number of vehicles past such a junction point, traffic should be permitted to flow from only one roadway at a time. It is axiomatic that traffic delays on both roadways are inevitable when the amount of traffic on the two approach roadways exceeds the capacity of the roadway beyond the junction point; so cumulative delays are avoidable only when there is a balance between the number of vehicles traveling on the two roadways and the common roadway beyond, and a coordination of time intervals with the number of vehicles moving on each approach roadway. Such delays occur where westbound traffic leaves the Queensboro Bridge by two roadways which mutually interfere, through clogging at times of congestion.

Tunnel Junctions and Crossings Taboo

Therefore, in the interests of economizing and of collecting tolls for rapid and uninterrupted movement in the tunnels, it was concluded that neither tunnel junctions nor branch approaches should be provided, and that traffic routes should converge in open-air plazas.

Studies on the subject of avoiding the crossing at grade of trucks and passenger cars indicated that there would

be great difficulty in providing the necessary arrangements for a single, two-way, double-deck tunnel, such as was originally proposed. Further studies revealed, in addition, that the difficulties of constructing a tunnel of such large dimensions in Manhattan rock would be so great that it would be easier and more economical to build separate tunnels in 37th and 38th streets.

The conclusions thus reached led to the alignment and plaza plan shown in Fig. 1.

Locating East-Side Approaches

At the Manhattan pierhead line the tunnel roadways are approximately 77 ft. below mean low water. The terrain of Manhattan in the vicinity of 37th and 38th streets rises gradually from the East River to Fifth Avenue, and then slopes by degrees from Sixth Avenue to the Hudson River. If the westbound roadway rose gradually from the pierhead line on a 3 per cent grade, which has been adopted as the maximum adverse grade, and extended straight west under 38th Street, it would reach grade on 38th Street, near Fifth Avenue. It would, of course, be unthinkable to place entrance and exit plazas for a vehicular tunnel in the vicinity of Fifth Avenue near 37th and 38th streets.

It will be generally conceded that entrances and exits on the East Side should lie somewhere between the East River and Third Avenue. The most congested cross streets in Mid-Manhattan appear to be those between 32nd and 45th streets. So it was considered advisable to offer an inducement to traffic originating in, or bound for, this part of Manhattan by placing entrance and exit plazas in the immediate vicinity of 37th and 38th streets.

On the east side of Manhattan the most economical location is found to be the area bounded by First and Second avenues and 36th and 38th streets. To locate the plaza one block further north, as some have advocated, would add $7,500,000 to the cost. In order to connect plazas thus located, with the river tubes, and to secure permissible grades, loops must be used. These considerations led to the plaza development indicated in Fig. 2.

Arrangements are such that incoming traffic can be readily stopped and held in the plaza, when necessary, in order to permit through traffic to move without interruption. Such regulation will not require coordination on the part of several men, as a single operator will be empowered to take necessary control measures. It is believed that the mingling of traffic beyond the junction of the two tunnels would inevitably lead to loss of time in the tunnel. In traveling around the loop, vehicles move only the horizontal distance necessary to negotiate the vertical interval between the street surface of First Avenue and the level of the roadway at the pierhead line.

Should through traffic prove to be so great in volume as to result in frequent or long delays to traffic desiring to enter the tunnels from the east side of Manhattan, the city could probably afford to construct a third tunnel, which would make it possible for the through traffic to travel from the Borough of Queens to Tenth Avenue, Manhattan, without coming to the surface. The question has been asked—why not make a direct underground connection between the river and land tunnels for use when traffic is light and there is no likelihood of delays and consequent congestion in the tunnels? The answer is that the cost of such a connection would be at least $6,000,000. Also, if vehicles are sometimes permitted

Fig. 1. General Plan of 38th Street Vehicular Tunnel

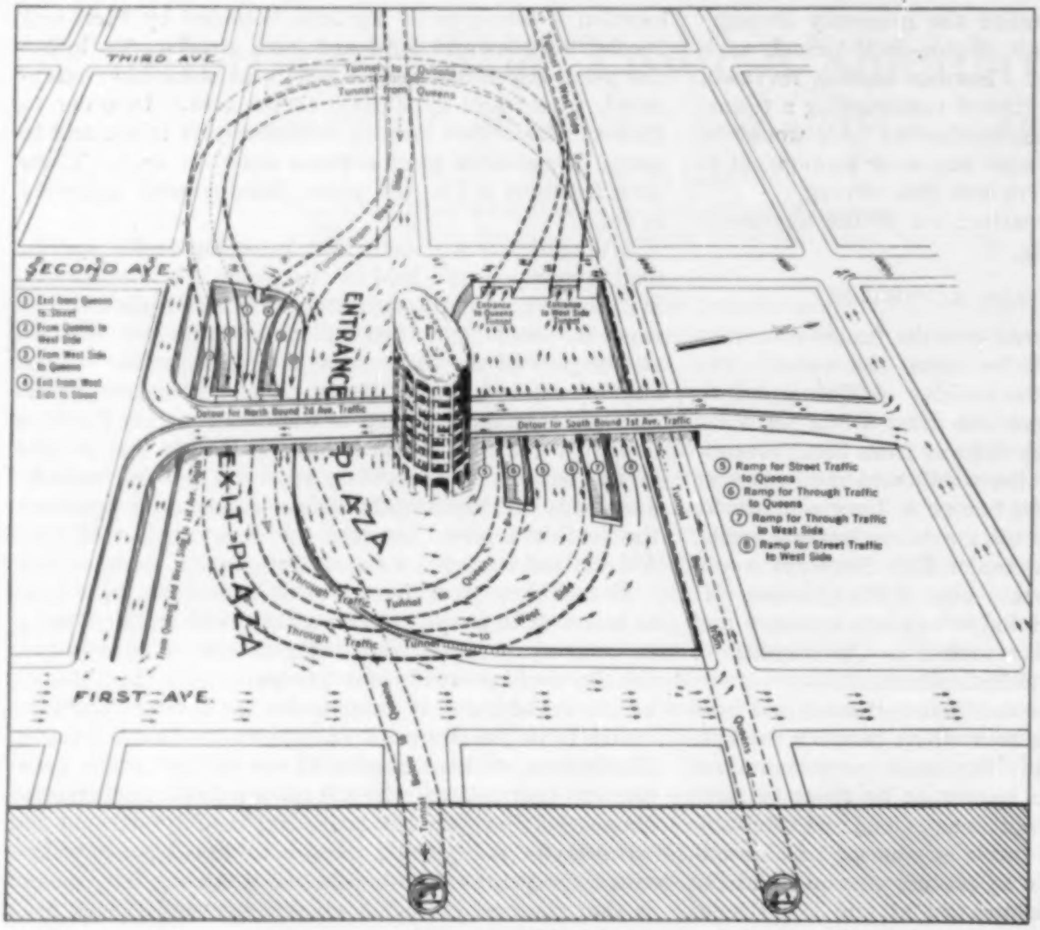


FIG. 2. PERSPECTIVE SKETCH SHOWING PROPOSED EAST SIDE PLAZA, LOOKING WEST

the Brooklyn and Manhattan tubes, in which local and through traffic are brought together, are depressed at the portals. The plan indicates rather extensive arrangements for eliminating grade crossings in the immediate vicinity of the Long Island City plaza. While such arrangements are not essential, they are regarded as important because of the extent to which vehicles leaving and approaching the plaza must use the same streets.

Plaza arrangements on the west side of Manhattan are still the subject of joint studies being made by the Port of New York Authority and the Board of Transportation.

The subject next in importance to alignment and plazas is ventilation. On this factor depends, to some extent, the section of the tubes. After studying the experience of the Holland Tube, the ventilation for the mid-town tunnel has been based on keeping the carbon monoxide content down to 2.5 parts per 10,000. In view of the growing tendency on the part of trucks to develop higher speeds, it has seemed wise to allow for the possibility of as many as 3,800 vehicles per hour moving in each tunnel, 50 per cent of these being trucks. Furthermore, the increased cost of providing ventila-

to go one way and at other times are required to go another way, the result will be hesitation on the part of drivers at the point of diversion and the consequent probability of delays in the tunnels. Furthermore, such a connection would, at best, save only 1.7 min. in time for a vehicle traveling the extra 3,100 ft. at 20 miles an hour—a saving easily offset by any irregularity of movement in the tunnels. It is also believed that traffic regulation in the tunnels should be as simple as possible, allowing the motorist the minimum of choice as to how he shall move.

In Long Island City, the preferred arrangement for the plaza is as shown in Fig. 3. On account of its distance from the river, no loops are necessary to reach it. Queens and Brooklyn traffic are separated in this plaza by arrangements similar to those used in Manhattan, and Brooklyn traffic uses depressed roadways connecting with the Brooklyn tunnel. The entrance plazas for both

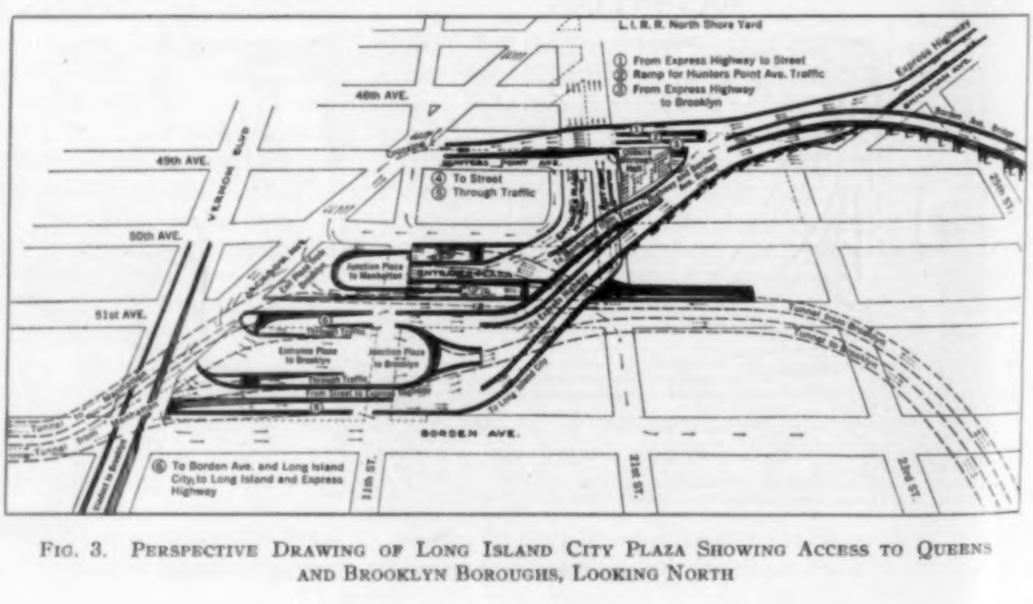


FIG. 3. PERSPECTIVE DRAWING OF LONG ISLAND CITY PLAZA SHOWING ACCESS TO QUEENS AND BROOKLYN BOROUGHS, LOOKING NORTH

tion for a larger number of vehicles is relatively small.

Each ventilation section will be provided with four fans for supplying fresh air and four others for exhausting the foul air. One fan in each group will be virtually in reserve except during times of maximum demand.

As a result of closely regulating the flow of air to the needs of traffic, the cost of ventilation will be materially reduced. Automatic remote control of the fans, according to the carbon monoxide content, is contemplated. A total of 28 ventilation sections and 224 fans will completely renew the air in the tunnel on the average of once every 54 sec. Fresh air will be supplied through the ducts below the floor, and foul air will be exhausted through the ducts over the ceiling.

Choice of Cross Section

As a result of careful studies of the relative construction and power costs for ventilating tunnels of different diameters, it appears that a structure 31 ft. in diameter will be cheaper in total ultimate cost than one of 30 ft. Accordingly, it is proposed to provide river tubes with an exterior diameter of 31 ft. (Fig. 4). The section of the land tunnels has not yet been determined.

Cast-iron tubes lined with concrete will be used. Consideration was given, at first, to the possibility of using structural steel lined with concrete, as in the recently completed Detroit Tunnel, and to the possible use of concrete blocks. The structural steel was rejected because the heavier cast-iron lining lends itself better to East River construction conditions, and there is insufficient saving in the use of the steel to offset the greater ease and safety of construction when the thoroughly tried-out cast iron is used. Concrete blocks were rejected because of the danger of movement of the tubes during construction—as a result of the fact that successive rings are not tied together—and because of doubt as to whether a concrete block tunnel under the East River could be made sufficiently water-tight for use as a vehicular tunnel. The trench method was not considered, because it was believed that it would not be possible to secure a permit from the War Department for this method of construction in the East River. Also, the economical removal of rock at the great depths involved presents a serious and, as yet, unsolved problem.

The roadway in the tube (Fig. 4), will be 21 ft. in width between curbs, instead of 20 ft. as in the Holland Tunnel. The headroom will be 13 ft. 6 in. This greater width of roadway will permit one lane to be used by vehicles 9 ft. in width and the other by vehicles

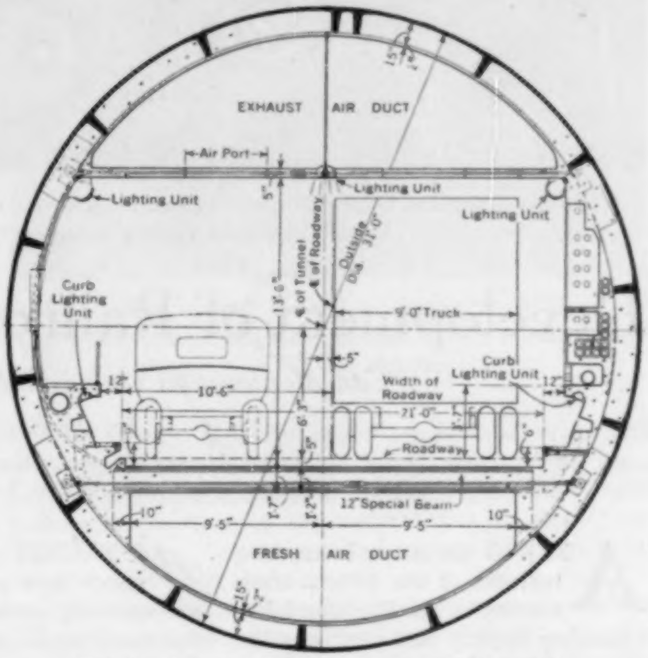


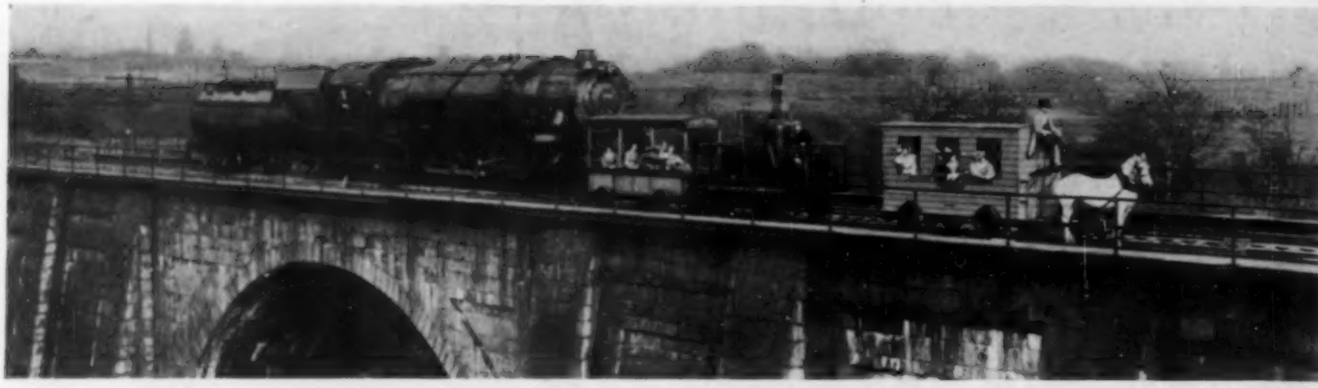
Fig. 4. Adopted Size for East River Tunnel
Indicating Many Incidental Details of Arrangement

8 ft. wide. This would be advantageous should 9-ft. vehicles become common.

Many men have worked long and efficiently in preparing these plans for a Mid-Manhattan Tunnel. The following, all members of the staff of the Board of Transportation, have been prominent: Robert Ridgway, Past-President Am. Soc. C.E., Chief Engineer; A. I. Raisman, M. Am. Soc. C.E., Chief Designing Engineer; H. M. Latey, M. Am. Soc. C.E., Chief Electrical Engineer; J. B. Snow, M. Am. Soc. C.E., Division Engineer of the Tunnel Division; C. E. Conover and J. H. Quimby, Members Am. Soc. C.E.; S. D. Bleich, B. B. F. Furre, and A. G. Goertz.

Load Test on Arch Span
Over Sandquart River, Switzerland

This $98^1/_2$-ft. span carries a single railroad track having a radius of 400 ft. The arch is 10 in. thick at the crown and $13^1/_2$ in. thick at the spring line. The bridge was designed and constructed in 1930 by R. Maillart, Geneva.



Horse Car and "Tom Thumb" Locomotive and Passenger Car of the 1830 Period with a Modern 330-Ton Eight-Wheeler
On the Carrollton Viaduct, Baltimore—One of the Oldest Stone Railroad Arches

Development of Railroad Passenger Terminals

Can Monumental Union Stations Be Economically Justified?

By Alonzo J. Hammond
Member American Society of Civil Engineers
Consulting Engineer, Chicago

Although barely one hundred years have elapsed since the first commercially successful steam locomotive made its initial trip in the United States, the quarter of a million miles of railroad built here since then are equal to one-third the total trackage of the world. In this article, prepared from his address before a joint meeting of the Milwaukee Section of the Society, the Milwaukee Engineering Society, and the Optimists' Club, Mr. Hammond reviews the development of our transcontinental railroads. He gives more particular attention to the types of terminals now in use, and to the relation of the terminal to the city. He discusses the problem of financing, in the face of a decline in passenger travel, such monumental terminals as the Chicago Union Station, the Pennsylvania, and the Grand Central in New York, and the terminals at Kansas City, Cleveland, and Cincinnati.

Among the many interesting features of the fiftieth anniversary of the Cleveland Engineering Society last year was the presentation of the portrait of one of the former presidents of that society. It was mounted in a frame surrounded by a repeating rifle, a revolver, and a knife, which represented the necessary tools of the early locating engineer of our Western railroads.

We are not so far removed, therefore, from the primitive conditions which marked the early history of transportation facilities in this country. A brief survey of the high points in the development of such carriers will show how rapid has been the transition from pioneer conditions to the comfort which the modern railroad offers its patrons.

Transportation between states began to develop immediately after the Revolution. Coastwise vessels carried products from the North to the South and into the interior on the rivers of the Atlantic coastal plain.

On the west, the Allegheny Mountains and their southern extensions acted as a barrier. For bulky goods the cost of transportation over the roadless mountains was prohibitive, as was strikingly shown by the Whisky Insurrection of 1798. Grain was too bulky to make profitable its transportation across the mountains, but whisky manufactured from it could be taken over at a profit. A heavy tax levied on this product, the sole exchangeable commodity of the territory west of the Alleghenies, caused the insurrection.

In 1807, the Cumberland Road, or National Pike, was projected, to run from Washington to the Mississippi River. In all, about $10,000,000 was spent upon it. The Erie Canal, begun in 1817, was completed in 1825 at a cost of $5,700,000. The annual revenue from it increased rapidly, so that in 1852 it was earning $3,500,000 a year from tolls.

Other canals were rapidly built and the early railroads were regarded as feeders for them. This was expressed by a Frenchman, Albert Chevalier, in his famous saying, "Merchants for the railways, merchandise for the waterways."

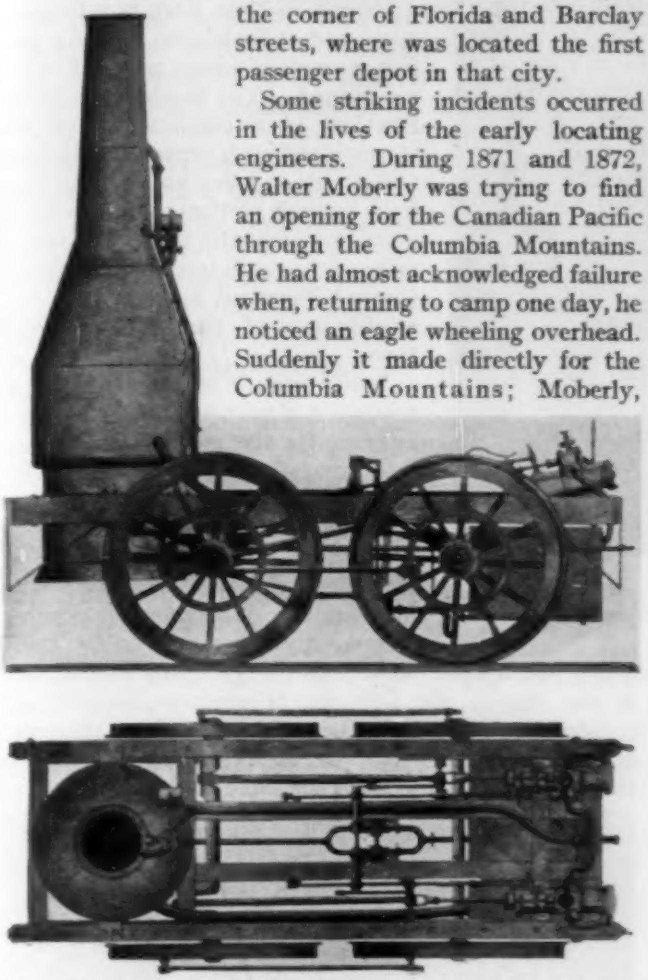
When Charles Dickens came to this country in 1842, he landed in Boston from a Cunard sailing packet. He rode from Boston to Springfield on the Boston and Albany Railroad, from Springfield to Hartford on a Connecticut River steamer, from Hartford to New Haven on the Hartford and New Haven Railroad, and from New Haven to New York by boat.

After the adaptation of the stationary engine to railroad use in 1829, when George Stephenson brought out his first locomotive, the "Rocket," there immediately developed a boom in railroad construction. On her trial trip the Rocket made 29 miles an hour with no bad results, although a German professor had denied the practicability of railroad travel on the ground that shooting through the air at such a speed would surely induce brain fever.

By 1830 the Baltimore and Ohio, the first railroad in this country, had 13 miles of road in operation. In September 1847, the newly organized Chicago and Galena Railroad employed a corps of engineers to survey and locate the line from Chicago to the Fox River. The engineer in charge was Richard P. Morgan (late Engineer of the Hudson River Railroad) who was paid a

salary of $2.50 per day. The railroad from Chicago to Galena, 182 miles, was estimated to cost $14,553 per mile, including fencing, engines, and cars. In 1855 the first trains ran into Milwaukee, to the corner of Florida and Barclay streets, where was located the first passenger depot in that city.

Some striking incidents occurred in the lives of the early locating engineers. During 1871 and 1872, Walter Moberly was trying to find an opening for the Canadian Pacific through the Columbia Mountains. He had almost acknowledged failure when, returning to camp one day, he noticed an eagle wheeling overhead. Suddenly it made directly for the Columbia Mountains; Moberly,



First Locomotive in Actual Service in the United States
Built by the West Point Foundry Association in 1830
From the Original Drawing, in the Possession of the Society

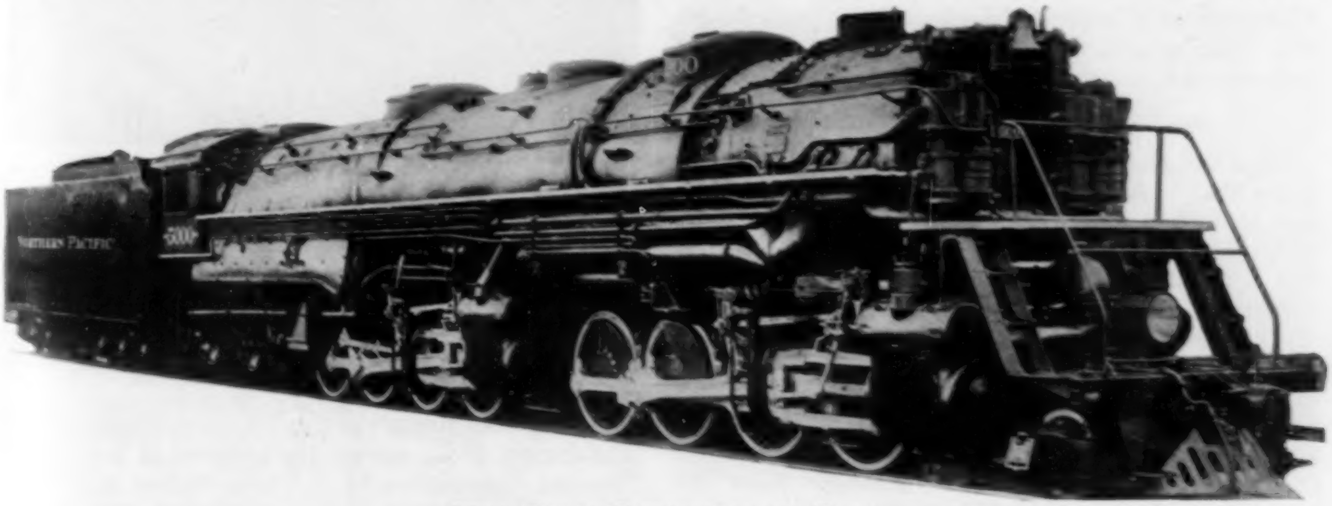
watching its flight, galloped hastily in the direction taken by the eagle. It flew straight as an arrow toward a projecting crest. Then, making a sharp turn, it was

The "Lion," Built in Boston in 1839
A Wood Burner in the Maine Lumber Service, Operated on Wooden Rails Armored with Strap Metal

lost to sight. Moberly swung around the crest, and there before him extended a broad canyon with great peaks massed on either side. Nature appeared to have fashioned this opening expressly for the advance of the steel highway. Out of gratitude to the bird, he christened the break in the mountain chain, "Eagle Pass."

There was also a tragic side to the construction of the early Western railroads. The "Iron Horse," a motion picture production of seven years ago, clearly delineated the difficulties encountered in constructing the Union Pacific and Central Pacific railroads from Council Bluffs to San Francisco. In this case the great problem of the Chief Engineer, the late Theodore D. Judah, M. Am. Soc. C.E., was not the finding of passes, but the protection of the track and train crews against hostile Indians. A monument to this engineer for his work in locating and building the Central Pacific Railroad was unveiled in April 1930, at Sacramento, Calif.

The day of the pioneer locating engineer who traveled on foot or by horseback, is past. By means of modern aerial reconnaissance and photography a terrain can be spread out in its entirety for minute and leisurely examination. It can be completely platted and the location line established from accurate projections.



One of Twelve Leviathans of the Rails
Weight 560 Tons; Fuel Capacity 22 Tons of Coal per Hour; Hauling Capacity 4,000 Tons on a 1 Per Cent Grade

The railroad played a pioneer rôle in the development of the country; and the practice of establishing town sites every five miles largely determined the spread of our urban population. The railroad was the dominant factor in urban growth and its right-of-way always occupied a strategic or central location in the towns through which it passed. As an example, recall how close to the site of Fort Dearborn in Chicago—at Michigan Avenue and the Chicago River—were the early stations of the Illinois Central, and of the Chicago and Northwestern railroads. It was a hard battle, some 18 years ago, to have all the stations, except the Northwestern, moved to the south of 12th Street, now Roosevelt Road.

CHICAGO UNION STATION
Concourse Next to Chicago River, Head House with Railroad Names on Roof

The railroads vied with one another in an effort to land their passengers as near as possible to the central business section of a city, and passengers weighed the advantages of the various roads in this respect. The same psychology prevailed in the development of the early river towns, in which the business section was adjacent to the river, where the river packets tied up.

In the same way, the traveling public is today prevailing upon the railroads to electrify, elevate, or depress their lines, as may be necessary in order to preserve the advantage of delivering passengers to a central location. The natural result is a combination of railroad terminals and, ultimately, the union passenger terminal.

THREE MAJOR TYPES OF TERMINALS

It has been the experience of the railroads of the United States that it is not possible to plan station facilities more than 25 or 30 years in advance. The last few years have seen such a striking decrease in passenger fares that it is still less possible to judge what the need for stations will be during the next 30 years.

In the case of the Chicago Union Station, one of the major passenger stations of the world, some ten years were spent in preliminary work before an approved plan was submitted. During that period, 30 different plans for the head house and concourse were prepared and a great many track layouts were studied. After the expenditure of more than $75,000,000 on the project, of which $35,000,000 was for land, it was felt that although the station served only four railroad systems, it merited its name.

In general, stations are of the stub, through, or loop types. The Northwestern Station in Chicago is of the stub type; the Pennsylvania in New York is a through type; and at Richmond, Va., is a perfect example of a loop, where all trains are turned. The Washington Union Station is a combination of the through and stub types; the Altantic Coast Line and the Seaboard Air Line have through stations; and the Baltimore and Ohio and the Pennsylvania railroads use stub tracks. The Grand Central Terminal in New York is a combination of the stub and loop types.

Public opinion in favor of the consolidation of railroads, which has been growing for the past 10 or 12 years, has broken down to a large degree the former objections of railroad managers to union passenger stations, although it must be admitted that there are conditions which make a union station undesirable. Wherever it is possible, it gives the traveling public much better accommodations. Also, by grouping several roads at one station, the financing of adequate facilities and construction can be much better provided for. Municipal authorities are usually strong advocates of the union station, which in a sense takes the place of the old city gate.

CHICAGO DAILY NEWS BUILDING
A Magnificent Modern Air-Right Development Over the North Station Yards of the Chicago Union Station

Naturally, the traveler's first impressions of a city are acquired at the terminal. If the terminal facilities appeal because of their commodious proportions and architectural design, he forms a favorable opinion of the railroad also.

The vigorous struggle put up by the railroads entering Washington, D.C., against the proposal of the Capitol Planning Commission for a Union Station will be recalled. The outcome of that contention was what is perhaps the finest station in the country, one of mag-

nificent proportions and well adapted to the peculiar needs of the capital.

More recent is the terrific ten-year battle Los Angeles has waged to get a union passenger terminal. This dispute even went to the U.S. Supreme Court for a definition of the powers of the Interstate Commerce Commission.

As generally considered, a passenger terminal consists of approach tracks which flare out into station tracks, with the protection of a train shed; and of the train concourse, the passenger concourse, and the head house—containing waiting rooms, ticket offices, parcel and baggage rooms, and other facilities.

Graham, Anderson, Probst and White—Architects

PROPOSED UNITED STATES POST OFFICE
Over South Station Yards, Chicago Union Station

The passenger concourse, as its name indicates, provides for the free movement of passengers from the waiting rooms to the track gates. The approach tracks must be adequate in number and provided with the necessary cross-overs and slip switches to secure the free movement of all trains in both directions. The station tracks must also be sufficiently numerous to accommodate all the trains which enter and leave the station, with allowance for the time required to load and unload, which is usually about twenty minutes. It is customary to consider that a station track of the stub-end type will accommodate two trains per hour, and that

TRACK LEVEL UNDER CHICAGO DAILY NEWS BUILDING
Smoke Vents Over Tracks

one of the through type will serve from two and a half to three trains per hour.

In the case of stub tracks, the train concourse at the end provides for the rapid movement of baggage and mail trucks from one track to another. This feature is lacking in European stations, where incoming and outgoing passengers are kept separated.

Committees of the American Railway Engineering Association have made careful studies of the relative proportions of all the facilities of a station as well as time studies of the movement of through and suburban passengers to determine the necessary widths of stairways, ramps, station platforms, and the proper sizes of waiting rooms, parcel rooms, and other areas.

In a stub-end station the unloading of baggage, mail, and express from incoming trains is usually held up until the passengers are out of the way and this causes a delay of from 5 to 6 min. per train. To avoid this wait, the Chicago Union Station provides separate baggage platforms wide enough for two trucks to pass. By this means the handling of trains is very materially accelerated. One of the very special features of this station is the train shed, probably the most elaborately designed and perhaps the most expensive that has ever been built. A great deal of study, time, and effort were expended in giving the most comfortable access to trains that a traveler could desire.

Although this shed is of the low, Bush type, the arches over the platforms give an effect of considerable height. These arches are glassed to admit sunlight and their tops are louvered to provide ventilation and to remove any smoke that might be diverted from the smoke vent by a down draft. The smoke vents are designed on the principle of the nozzle—all the smoke is gathered at the

LA SALLE STREET STATION, CHICAGO
New York Central and Rock Island Lines

base of an opening of ample width and shot through a curved aperture, smaller at the top than at the bottom, so as to prevent a down draft, which might occur under certain barometric conditions with adverse air currents.

GRAND CENTRAL TERMINAL, NEW YORK, WITH THE NEW YORK CENTRAL BUILDING IN THE BACKGROUND

Both Are Built Over the Tracks and Straddle Park Avenue. Street Traffic Passes Around Terminal and Through Building on Elevated Roadways, One of Which Is Shown

Many other details have been provided for the comfort of the traveler, among them the arrangement of booths so that he can buy a ticket and a Pullman reservation at the same time; the location of little benches to put parcels on, so that he can keep his knees against them and prevent possible thefts; the nearness of both parcel and baggage rooms to the ticket office; and the provision of a quiet waiting room distant from hurrying commuters—all these features promote the comfort of the traveling public.

A perfect example of a union passenger terminal development is that now under way in Cincinnati. All the railroads entering that city are combining in the new passenger terminal, which will include coach yards and an engine terminal. This station is of the through type, with loop tracks. The station plaza is much higher than the surrounding streets in order to protect the tracks from high water. Cabs, buses, and trolleys circle around the plaza, under the semicircular concourse, where there are platforms for each separate line of travel. The passengers use ramps leading to the station, and the flow of travel is past the ticket windows, parcel and baggage check rooms, to the waiting room and train concourse. Incoming passengers use the opposite side of the semicircle to reach the transportation facilities just opposite their entrance.

PASSENGER TERMINALS AS A FINANCIAL INVESTMENT

With a diminishing passenger business, the railroads as a rule now look with disfavor on expenditures for the improvement of passenger facilities. It is rather curious that, in spite of this situation, numerous large terminal projects are under way or recently completed. A passenger terminal might well be considered a good investment.

Several years ago a railway operating official made the following comparisons between the cost and the income from several large terminals in this country. The Pennsylvania Station in New York, which cost between 110 and 120 million dollars, had at that time an annual gross passenger business of $37,000,000, of which about 50 per cent, or $18,500,000, was from New York. The annual fixed charges—for taxes, depreciation, operation, and maintenance—were about $14,000,000. That is, the terminal charges nearly equaled the gross business. All the stations on the line from New York to Washington represented an investment of $178,000,000, or $800,000 per mile for the 223 miles of track between the two cities.

Yet the Pennsylvania has found it necessary to revise its terminal facilities in Philadelphia, and to reroute all the through trains by way of a new station at West Philadelphia. Suburban service is carried into a terminal near the present Broad Street Station. The proposed real estate development and lease of air rights over the property extending from Broad Street to the Schuylkill River may help to reimburse the road for these large expenditures in Philadelphia.

The Grand Central Terminal in New York cost around $200,000,000, and its fixed and operating charges amounted to about $23,000,000. Gross annual passenger receipts were $55,000,000, and if 50 per cent came from New York, or $27,500,000, then the terminal charges were 80 per cent of the gross passenger receipts.

As for the Kansas City Station, which cost $40,000,000, of which $11,000,000 was for the station itself, it is said that some of the roads using it pay more for the privilege than the amount of their gross receipts from Kansas City business. In the case of the Cleveland Station, recently opened, the cost of the terminal alone

NEW YORK CENTRAL BUILDING, PARK AVENUE, NEW YORK

Terminal Trackage Occupies Entire Area Under Park Avenue and Under Buildings Facing on It

was about \$88,000,000, including electrification. Other items, including the purchase of electric locomotives, land carrying charges, and the railroad improvements themselves, necessitated the expenditure of about \$40,000,000 more.

The Illinois Central Station in Chicago has been planned to serve a large number of the railroads in addition to those now using the station, and the complete plans show a mammoth two-level station, with interurban tracks on the lower level as a through station, and stub tracks on the upper level. So far, other railroads have been discouraged by the proposed terminal charges, and it remains to be seen whether the station will be built as originally planned or cut down in size to meet immediate needs.

Pennsylvania Station, New York
Post Office in Foreground Built Over the Tracks

AIR RIGHTS HAVE BECOME VALUABLE

It is a well known fact that the development of the air rights of the Grand Central Terminal property in New York, following electrification, made that station a profitable investment, and it is expected the Philadelphia terminal development of the Pennsylvania will result in similar profit. In Chicago, where steam locomotives must still be used, elaborate experimental work on handling smoke from the locomotives by exhaust fans and conduits was carried on during the construction of the Chicago Union Station. The success of the results obtained there has made possible the construction of the monumental Daily News Building over the tracks in the area between Canal Street and the river and between Washington and Madison streets. More recently, the Government has purchased the air rights over the entire width of the tracks of the Chicago Union Station Company from Van Buren to Harrison streets—a distance of 800 ft. A contract has just been made for the construction of what will be the largest post office in the world, to occupy this area. Thus there has been a distinct advance in the utilization of air rights.

At present, the trend of popular opinion and of current railroad practice is for a more widespread combination of railroad facilities, both for passengers and for freight, but particularly for passengers. If the railway companies should undertake to operate buses as feeders, the question of union passenger service would become more acute and would require more intensive study. Well coordinated facilities would be needed to meet some of the criticisms which our mammoth stations have called forth in the past. Yet there is another side to this question, well expressed by an acquaintance of mine, an editor from Indiana: "The genius of the American people runs to transportation and to business. Why not express through these mediums the artistic soul of the Nation."

Pennsylvania Station, New York, at Train Time

The Way to National Progress and Prosperity

By C. E. GRUNSKY
PAST-PRESIDENT AMERICAN SOCIETY OF CIVIL ENGINEERS
PRESIDENT AMERICAN ENGINEERING COUNCIL

FOR a number of months past, the Engineering Foundation has been releasing short articles as part of a symposium on the benefits to industry, commerce, and education that result from engineering progress. In this thoughtful article, which is one of the series, Dr. Grunsky pleads for money to be spent on the cultural uplift of the nation even to an amount comparable to that expended for safeguarding life and property. He suggests a redistribution of taxation to make it more compatible with ability to pay, and a careful examination into the many indirect bonuses now granted to certain individuals and organizations at the expense of others not so privileged. He is a member of President Hoover's Organization on Unemployment Relief.

UNEMPLOYMENT is the most striking symptom of recurrent hard times. Attribute this, if you please, to the fact that one man now produces what three or more could produce a few years ago, but remember that demand in kind and quantity also has vastly increased. Depressions would be recurrent even if the typewriter, the harvester, and the automobile had not been invented. The relative number of basic producers has been materially decreased. In consequence, increasing numbers must be provided with occupation in distribution, cultural activities, and recreation.

Opportunity to work should be provided for every person dependent on his own efforts. Obviously this opportunity cannot be supplied at the bottom of the scale of human endeavor. Over-production would result. There is always room at the top. The great need is for a stabilizer in the form of activities disconnected from the production of material necessaries, which will provide in every country a steady flow of money from hand to hand. This stabilizer is close at hand. It will not prevent, but it will mitigate recurrent business depressions.

MATERIAL WELFARE NOT ENOUGH

The nation's spiritual and cultural advancement is of greater importance than provision for material well-being. Expenditures of public funds for such purposes, comparable with those spent for the safeguarding of life and property, for the protection of health, and for facilitating the exchange of products, would not be unreasonable; but there is fear of the tax burden.

Under a balanced program, the nation should get vastly increased scientific research; expansion of educational opportunity; and encouragement of art by the erection of monuments, the establishment of museums, art galleries, conservatories of music, and opera houses, with maintenance of opera companies, in all centers of population. These expenditures would contribute to the spiritual uplift of the people and to the progress of civilization. Provision for outdoor recreation should be made throughout the land on a scale never yet approached. Lands should be reserved and acquired so that those who go into the open can find suitable places to picnic and to camp. During periods of declining prices there should be also a speeding up of public works, according to a sane program. Recourse to pick and shovel, instead of to modern appliances, is but a trifle better than the giving of a dole, with its encouragement of idleness and of a return to primitive conditions.

The basis of such a program is a high rate of taxation; but any suggestion that the Government spend more money, particularly in business depressions, is commonly frowned down. The fact is ignored that when capitalists close their purses, the Government must spend to avert disaster. Objection should not be made to the magnitude of the sum to be raised, but to the prevailing unfair systems of apportioning the tax. If the burden were distributed commensurately with the ability to pay, there would be less dissatisfaction, and the public would soon learn that the greater the tax, the less the slump in the aggregate volume of the country's business.

Tax money thus put into circulation would create a volume of business that could readily bear the tax from year to year. To make this clear let it be supposed that times are hard and money scarce and that Jones has run up a bill of $100 at the grocer's. The grocer has gone into debt to a truck gardener for the same amount; the truck gardener owes the butcher $100; the butcher owes the baker; the baker owes the plumber, and so on 100 times. The total indebtedness is $10,000, with 100 persons complaining of the difficulty of making collections. Jones finds employment and pays his grocery bill. The grocer pays the truck gardener with the $100 received from Jones, and so on until a single $100 in a few days may have reduced outstanding indebtedness by $10,000.

The dollar, when started, keeps on going from person to person—normally from about 30 to 50 times in a year—until hoarded somewhere or until its speed is checked during some business depression. If money received from taxation, equitably levied, is economically spent at home, it will in passing from hand to hand create in the long run business for each taxpayer in substantially the proportion in which he has contributed. Each dollar thus expended by the Government should create from $30 to $50 of business in a year with, of course, some annual shrinkage. There appears no reason, in theory, why taxes should not be welcomed.

TAXES INEQUITABLY DISTRIBUTED

Much unproductive property, such as furniture and works of art, is too heavily taxed. So also is real estate. Why tax the goods or the material which the merchant and manufacturer have in stock when their business is "in the red"? They should pay something for the privilege of doing business, based on the volume of business, and

they should contribute to the Government a part of the net profits. The tax on real estate should be just enough to prevent the land from lying idle too long. The main guide in fixing the individual's tax should be ability to pay, that is to say, his net income. Taxes should be graded and there might well be a minimum below which there would be no taxes.

Indirect bonuses have increased the tax burden of those who do not get such bonuses. The veteran is granted tax exemption, amounting in some states to \$1,000, an indirect bonus perhaps equivalent to \$40 or \$50 per year. Such exemption has almost universal approval. However, another veteran, with wife and children, in rented quarters, who cannot, therefore, benefit from the exemption, does not get the indirect bonus for which he is probably in much greater need. The exemption is unfair. Every such bonus should be direct, not indirect.

Salaries of public employees and officials are tax free—equivalent to an addition to the individual's earnings—an indirect bonus largest for those with largest incomes, who could best afford to pay an income tax. Earned incomes are exempted from the Federal base tax to an extent of 25 per cent. An indirect bonus equivalent to the tax on \$1,250 is thus given to the man who has a salary of \$5,000. His neighbor, whose earned income is \$30,000, obtains an indirect bonus six times as great, and yet the latter is in a better position to pay. Scientific, religious, and like institutions are exempt and this exemption is equivalent to giving a bonus. To the extent of the aggregate indirect bonuses thus granted, the other taxpayers carry a heavier burden.

Government, state, and municipal bonds are tax free, supposedly to the advantage of the public, because they thus become marketable at lower rates of interest—only a fancied advantage that may lead to injustice. All the bonds issued by some municipality may be held by residents of another. In the second city a corresponding amount of property is taken off the tax list, with the result that all other property is more heavily taxed. The increased burden results in advantage to the residents of another municipality in which those who are thus more heavily taxed may have no interest. If all bonds issued by a municipality are owned by residents of that municipality, the tax rate on the remaining property must go up in an amount that will more than offset the advantage which results from the low interest rate at which the bonds were issued. If the holder of the bonds did not profit by the tax exemption, the low interest rate bonds would not be attractive. Another indirect bonus!

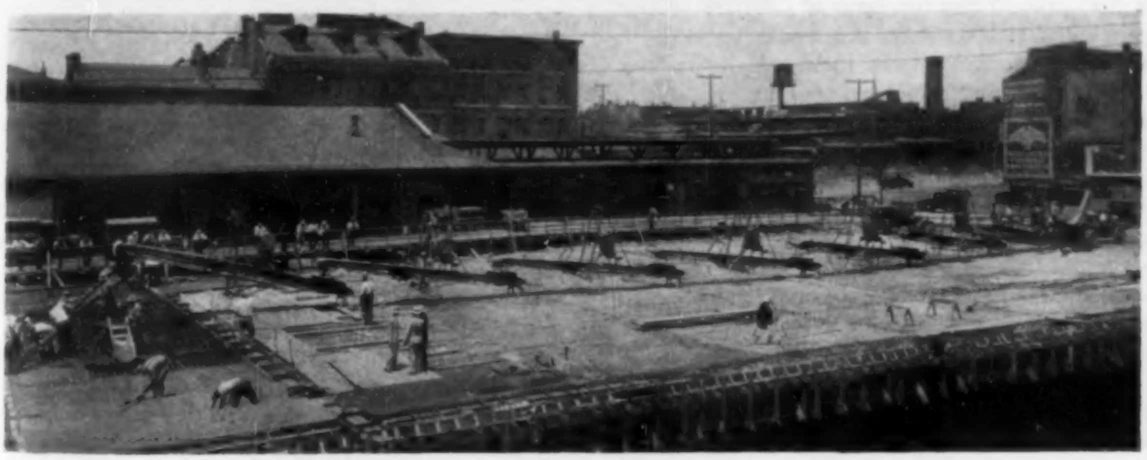
Inequitable Financing of Public Projects

When the Panama Canal was constructed, bonds for nearly \$400,000,000 were issued. These bonds went into the hands of bankers, who deposited them in the United States Treasury for the privilege of issuing bank notes secured by these bonds. The bank notes, which may have approximated 90 per cent of the amount of outstanding bonds, went into circulation as currency, the banks being thus permitted to borrow from the public, at a small cost for engraving and a moderate tax, several hundred millions of dollars without paying interest—an indirect bonus.

Under the Reclamation Act of 1902 and its amendments, the settler is required to pay back to the Government within 40 years the cost of irrigation works, but without interest, an indirect bonus practically equivalent to the cost of the works. The works, if constructed privately, would have cost the settler twice as much.

Several cities in Kansas have no taxes, a situation welcomed by all. The cost of government has been shifted from the taxpayer to the rate payer in water, light, and power bills, and in car fares. The public utilities are owned by the municipalities and the profits are sufficient to meet the budget requirements. By this arrangement the wealthy have been relieved of their just share in the cost of government at the expense of those in moderate circumstances. The real estate owners and the capitalists are in fact presented with an indirect bonus.

Other illustrations could be given to indicate how general indirect bonuses have become. Equitable taxes and a fair distribution of the cost of government are the first steps which should precede the expansion of activities for cultural progress and public welfare, as a means of preventing extreme distress during business depressions.



Placing Concrete with Belt Conveyors

Eight portable belt conveyors, each 24 in. wide and 26 ft. long and equipped with its own power unit, deliver ready-mixed concrete from truck to forms on the \$15,000,000 Illinois Terminal Subway Project, St. Louis.

Engineering Problems in the Tropics

Soils, Foundations, Materials of Construction, and Meteorology

By Carl B. Andrews

Associate Member American Society of Civil Engineers
Professor of Civil Engineering, University of Hawaii, Honolulu

MOST of the information contained in standard civil engineering handbooks on the subject of soil bearing values, rainfall, run-offs, stream characteristics, maximum wind velocities, and other results of natural processes, has been obtained from observations made in temperate climates. Because of the dissimilarity of the processes of nature in tropical regions from those in temperate zones, some of the data which are current in engineering practice do not apply in localities with a warm climate. Some of the most obvious of these differences are mentioned in this article, which may serve as a guide to those who are working in the tropics for the first time.

ENGINEERING work in the tropics is unlike similar work in the temperate zones because of essential differences in the raw materials, in the climate, and in the customs of the people. The third classification, involving social, economic, and laboring problems, constitutes the greatest difference of all. However, this is not as important for engineering considerations as are the other differences.

The igneous or metamorphic rocks found in tropical regions do not differ materially from those of the temperate zones. Rock of coral origin, however, is never found outside of the belt lying between 30 deg. north and 30 deg. south of the equator. In fact, it is found most frequently within the tropical zone proper. Much of the Atlantic Ocean, even in the tropical region, is free from coral, its growth in these waters being mainly confined to the West Indies and to the coast of Central America. Coral is found on most of the tropical islands of the Pacific, the East Indies, the tropical coast of Australia, and along coasts of the Indian Ocean and the Red Sea.

FORMATION OF CORAL REEFS

The coral animal is of the sea anemone type. It is unable to live in fresh water and grows only in comparatively warm sea water. When it dies, as the result of the accumulation of silt and debris, the skeleton remains to form the dead coral rock of the reef. The living coral will be found in the clean ocean water. It grows on the seaward and top faces of the mass, which is made up of the skeletons of coral animals, together with fragments broken from some of them, sand, and pieces of shell, the whole being cemented together by the finest of the sand grains, which form an ooze or mud. The reef never rises above high-water level.

Blocks, cut from the dead coral reef, make fair building stones. Structures made of them will often be found in tropical coast towns where the coral reef rock is obtainable. The blocks are fairly porous and, when built into a wall, should be plastered to make them weatherproof and to prevent weathering. Structures built of these blocks are often enduring because of the massiveness of the walls. Although the blocks may be easily cut from the reef, they harden upon exposure to the air, as do some of the other more fine-grained limestones. The walls of the Morro and Cabañas fortresses at Havana, Cuba, have been built mostly, if not entirely, of this type of stone.

Coral reefs may be raised above sea level by an emergence of the land. In this case, what was originally a fringing reef will form a practically level plain, unless the emergence has been accompanied by tilting. The stone, under these conditions, is likely to assume a flinty hardness of surface. Such land emergence has taken place on the Island of Oahu, of the Hawaiian group, as is evidenced by the extensive coral plain near Barber's Point. One of the valleys near Koko Head, at the southeast end of Oahu, shows coral reef deposits about half a mile inland from the mouth of the valley. This indicates that a submergence, after the valley was eroded, was followed by an emergence which raised the coral reef nearly 15 ft. above sea level.

Lime may be produced by burning coral reef rock, or sandstone made up of coral sand. The lime is likely to be a "short" lime and is not favored by brick and stone masons if a "fat" lime is available.

Coral sand is the product resulting from the grinding up of fragments of dead coral and the shells of marine animals by the waves. There are also certain sea animals which swallow coral fragments and reduce them to sand and mud. The sand found on beaches may be coarse or fine, varying from a grain diameter of 0.2 mm. to one of 1.0 mm. It is of a clean cream color, and, since the material is comparatively soft (calcium carbonate), the grains have no sharp angles.

CONCRETE FROM CORAL SAND

Mortar or concrete made with this sand is poor in fire-resisting quality, as the sand grains will burn to lime under a sufficiently high temperature. Concrete made with coral sand is rather fluid and fills forms easily and fully—probably because of the large percentage of flattish grains present in the sand. This is a valuable characteristic which, if properly utilized, enables the workman to easily produce a dense but workable concrete. Concrete made with a mixture of coral sand and crushed stone dust has been found to be stronger than concrete made with only crushed stone dust as the fine aggregate.

The sand is found on sea beaches, in wind-blown dunes near the seashore, and more rarely in deposits some distance back from the shore, which may represent either former beaches or old dunes. Sands of other than coral origin are also found in the tropics, but these are not essentially different, in their physical characteristics, from the sands of the temperate regions.

Occasionally there are found layers of cemented coral sand grains, which form a fairly strong stone. The cementing material appears to be a calcareous deposit, probably from fresh water, the deposit being the result of the evaporation of the water. Such stone has been used to a certain extent for building purposes, although it is by no means comparable to the stone usually known as sandstone. These coral sandstone layers are generally found near sea level or a few feet above it. In the hills back of Kahuku, on the Island of Oahu, coral sandstone, which is formed by the cementation of dunes of wind-blown sands, is found at elevations as high as 350 ft. above sea level, in layers visibly 30 or 40 ft. thick.

Coral stone is sometimes used as road metal in the construction of water-bound macadam roads. It is not a durable material for this purpose, as it wears quickly. However, it also crushes easily and compacts readily under a roller, so that it is often found to be a convenient and good material for roads intended for light traffic. The mud which forms on such a road is very slippery. In fact, extreme fluidity seems to be a characteristic of the mud formed by this fine detritus of coral origin.

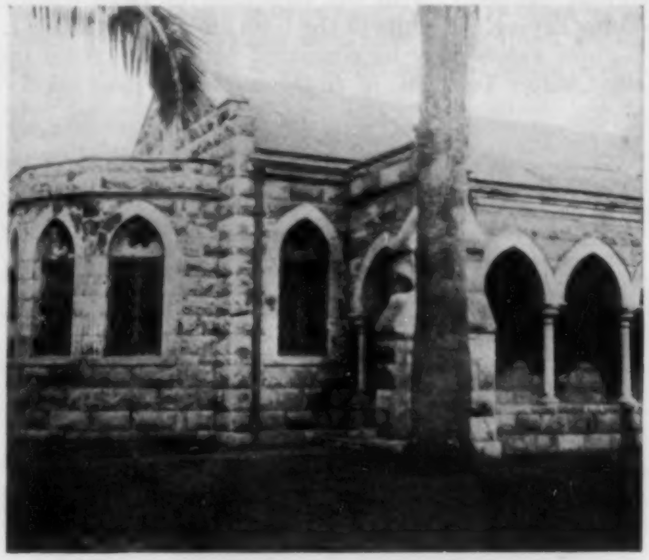
The Waikiki region of Honolulu contains in its sub-soil such a layer of coral mud and laterite clay. The material in this layer is very fluid under pressure when saturated with water. The foundations for the gun emplacements at Fort De Russy, at Waikiki Beach, rest on concrete piles which were driven through the layer, from 15 to 20 ft. thick, to a bed of "finger coral" (a loose accumulation of coral fragments about the size and shape of a man's finger), which was beneath it

Wall Built of Coral Stone Block
Constructed Before 1840 Around Old Mission Premises, Honolulu

Because of its great mobility this bed of mud is not suited to the carrying of heavy loads.

Laterite Soil Swells with Moisture

The "clays" of tropical regions are likely to be laterite rather than true clay. Laterite is described by Twenhofel, in his *Treatise on Sedimentation*, as the residual product of rock decomposition in tropical and subtropical regions where there is no frost action to destroy the porosity of the material. The result is a more complete



St. Andrews Cathedral, Honolulu
Built of Sandstone, Formed from Coral Sand Grains

decomposition of the silicates than in the temperate zones, so that the residual products (which make up laterite) consist essentially of ferric and aluminum hydroxides and free silica, the proportions varying with the locality and the composition of the particular rock from which the material was derived.

Laterite has the characteristic property of shrinking greatly during drying, and the corresponding property of absorbing a great deal of water during wetting, and expanding because of this absorption. It is also characteristic of the material that, when light structures with only a slight depth of foundation rest on it, they are gradually distorted by non-uniform settlement. The laterite carries the load successfully where it is kept dry, but the walls or posts on the rain-exposed side of the building gradually sink into the soil, which becomes plastic with each wetting. So far as I know, the problem of the erection of heavy buildings on laterite has never been discussed in any engineer's handbook, and engineers and architects who have faced the situation have had to acquire their knowledge of the behavior of laterite through experience—largely at the expense of their clients.

Tests have recently been made at the University of Hawaii on a typical blue-gray laterite. The results of these tests show, by comparison with the results of similar tests on temperate-zone clays, the characteristic differences between laterite and clay. The material was undoubtedly originally deposited as a wash from near-by hills, and the specimen was taken from about 5 ft. below the surface at the site of a new

auditorium building on the university campus. It is a typical laterite of the kind which flows slowly under pressure, swells greatly under an excess of water, and shrinks markedly, with the formation of large cracks, during drying. Results of the tests are given in Table I.

These values may be compared with those given by Dr. Charles Terzaghi, in *Erdbaumechanik*, page 70, for four clays from the region of the Bosphorus. His values are as follows:

WALL AND MOAT, CABANAS FORTRESS, HAVANA
Moat Excavated in Solid Coral Rock, and Masonry Made of Coral Stone Blocks

Lower liquid limit . .	58.0	56.7	67.2	58.1
Plastic limit	24.2	27.5	29.0	26.2
Plasticity index . .	33.8	29.2	38.2	31.9
Shrinkage limit . .	12.4–14.3	8.8	9.5	11.1–12.3
Coefficient of expansion	52.7	..	22.3	73.0
Specific gravity . .	2.93	2.77	2.72	2.85

The differences between the laterite and the clays appear especially in the consistency limits and in the time of slaking, which, for clays, varies between 10 min. and 60 min., but which rarely falls below 10 min. unless there is a considerable admixture of silt. The grain size distribution curve of this laterite is comparable to that of a silt, and the times of slaking of the laterite and the silt are about the same. The high lower liquid limit and plasticity index of the laterite indicate its great capacity for holding water, and probably result from the fact that iron and aluminum are present in the laterite in the form of hydrates.

FOUNDATION PROBLEMS

It is not practicable to drive piles into fairly dry laterite, as they shatter after a penetration of from 6 to 12 ft. If depth bearing is desired, pits may be dug or bored, and later filled with concrete. The solution of the problem of foundation construction in laterite perhaps may lie in the construction of a fairly heavy reinforced concrete slab, beneath which may be placed a number of concrete piers cast in pits, which will serve to transmit some of the slab load to deeper strata if the surface stratum should become plastic through wetting.

The foundation problems peculiar to tropical regions owe their existence to the characteristics of the material on which the foundations rest. Structures built on coral reef rock will generally be near the sea. The structure may be a wharf, or building, resting on piles driven through the overlying mud, sand, gravel, or surface soil to the reef rock. In the case of any structure which is to rest on piles to be driven to the surface of the coral reef, the necessary length of each pile should be determined before construction begins by sounding to the coral surface at the site of each pile. The reason for this is that, as a coral reef grows, it may reach a maximum height of a little below high water. However, all parts of the surface do not usually grow to this height.

UNEVEN SURFACES OF CORAL REEFS

In the surface of a coral reef, there are generally holes of all sizes, some being about 20 ft. in diameter and 20 ft. deep, or even larger. In the living reef these holes, which are filled with water, may accumulate some sand and coral fragments. The holes in a dead reef, back from the surf line, tend to fill up with any material that is at hand. In either case, if a pile location happens to fall in one of these holes, it may be that that particular pile should be considerably longer than its neighbor a few feet away, which does not fall in the hole. The irregularities of the upper surface of a living coral reef may be most advantageously observed from a glass-bottomed boat. The work of sounding, especially for wharf construction, is not easy, and it requires an experienced crew and special equipment.

In placing structures on coral layers, composed either of undisturbed reef rock, or of accumulations of more or less consolidated fragments, or of sand, it should be remembered that all coral is porous, and that water passes through it quite freely. The failure of the partly constructed dry-dock at Pearl Harbor in 1913 was

TABLE I. RESULTS OF TESTS ON LATERITE FROM UNIVERSITY OF HAWAII CAMPUS

Lower liquid limit (weight of water in percentage of weight of dry material)	91.3
Plastic limit	39.5
Plasticity index	51.85
Shrinkage limit	14.7
Coefficient of expansion	26.9
Equation of expansion curve	$e = -\frac{1}{26.9}\log_e(p + 0.043) + 0.963$
Permeability index (cm. per min.)	1.86×10^{-7}
Voids ration of the material in its natural state (average) . .	0.45
Time of slaking of standard specimen	3 min.
Specific gravity	2.76
Size of smallest grains, by micrometer microscope . . .	about 0.0003 mm
Grain size distribution:	

10 per cent	< 0.125	mm. diam.
13 per cent	< 0.125	mm.
	> 0.0625	mm.
18 per cent	< 0.0625	mm.
	> 0.03125	mm.
39 per cent	< 0.03125	mm.
	> 0.01566	mm.
20 per cent	< 0.01566	mm.

Chemical composition of air-dry specimen (determination by T. P. Sedgwick):

Silica (determined as SiO_2)	39.46 per cent
Iron and alumina (determined as Fe_2O_3 and Al_2O_3) . . .	39.6 per cent
Loss on ignition (mostly hygroscopic and chemically combined water)	16.12 per cent
Calcium and other substances	balance

caused by upward hydrostatic pressure, due to the fact that the structure rested on finger coral, into which piles had been driven. The flotation effect was greater than the downward forces and resistances.

MATERIALS OF CONSTRUCTION

Most tropical countries do not manufacture steel, in spite of the fact that there are often deposits of both coal and oil in the tropics. The principal difficulty encountered in structural steelwork in the tropics is usually that of transporting the steel from the country where it is made to the place where the structure is to be erected. Shipments are often divided between several steamers. Even if the steel plates for a stack arrive at their destination on time, the anchor bolts for the same structure are apt to be on another vessel which may run aground in the course of her voyage and have to be unloaded and repaired before proceeding, thereby delaying the erection of the stack for several months.

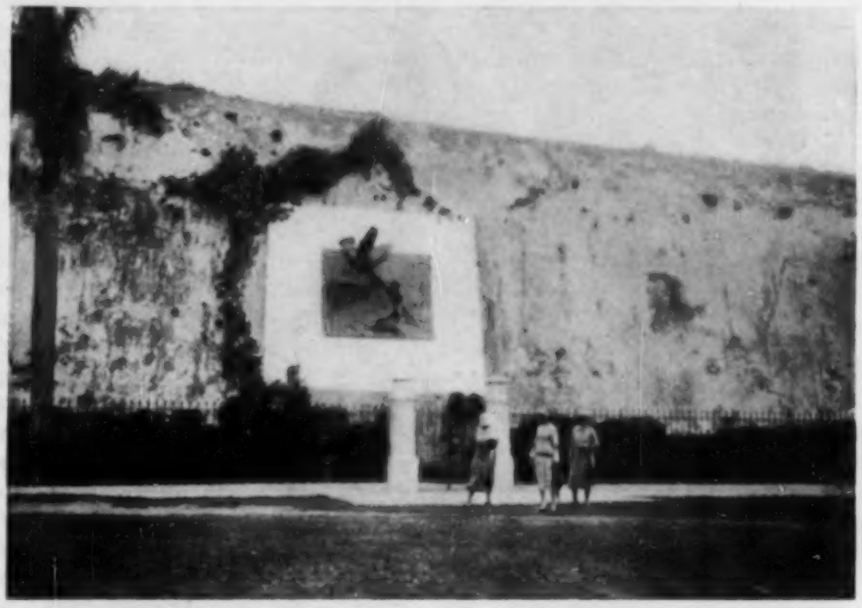
The conditions which control the unloading of vessels at the port of discharge, and the transportation of the material from that point to its ultimate destination, will sometimes influence the design or materials of the structure. The delivery, transportation, and erection of steel structures require personal dealing with the inhabitants of the country in which operations take place, and in this part of the work the engineer is often called upon to exercise a great deal of patience. Frequently unavoidable delays may be counted one of the difficulties of construction work in the tropics.

A certain amount of cement is manufactured in the tropical countries of Asia, but, in general, cement must be obtained from cooler lands, where the fuel resources have been more fully developed. If cement is obtainable, concrete work offers no especial problems, and brick and stone masonry work is common in tropical regions. Workmen accustomed to laying brick and mixing concrete are generally easily found. However, special brickwork, such as the settings for modern boilers, may require the importation of a bricklayer accustomed to do such work.

TROPICAL LUMBER HARD TO GET

Although the forest timbers of the tropics are abundant in many places, they are expensive and difficult to obtain. In sparsely inhabited regions there are few roads, and the transportation of felled timber, even for comparatively short distances, is expensive. In densely inhabited regions, the forests are in unarable and inaccessible areas, because land which is suitable for cultivation has already been cleared.

A sugar mill corporation, which began operations on the Island of Luzon in 1920, imported Douglas fir lumber from the Puget Sound region for the building of 5-ton sugar-cane cars, rather than attempt to buy lumber locally, although the mill was less than 60 miles from Manila, where there were lumber companies. The corporation had also obtained from the Government a timber concession which permitted it to fell wood in the Zambales Mountains, which were but a few miles away. The tropical forest is a jungle, made up of trees of many sorts. Therefore, a lumberman trying to obtain a particular kind of wood will often have to cut down a number of other trees in order to get at the ones he wants.



Memorial Tablet in the Moat of Cabanas Fortress, Havana

If there is no market for these other trees, the cost of their felling must be added to the cost of the timber which is finally marketed.

ENEMIES OF WOODEN STRUCTURES

Of the various insects which are ruinous in their effect on lumber and which are more active in warm climates than in cool ones, the termites are probably the most destructive. The name "white ants," which has been applied to them, is a misnomer, in that they are not ants at all. Since the social and working organization of the termites is very similar to that of ants, one who is not familiar with them is apt to mistake them for ants. Termites are by no means confined to tropical regions, as there is at least one kind which is native to the Arizona-New Mexico region and present to some degree in the cities of Southern California. However, the tropical regions of Asia, the East Indies, and northern Australia seem to be more seriously affected by termites than do most other localities. There are many types of termites, some of which are more destructive than others. The "anae" of the Philippines, or earth-inhabiting termites, build earth mounds so that the colony can live above the level of the groundwater in time of heavy rain. It is said that these insects can destroy a light bamboo house in one or two days, and an ordinary frame dwelling in a few months.

The methods of combating them are not as yet perfected. If the home of the colony can be found, carbon bisulphide poured into the runways is very effective. Even ground treated with carbon bisulphide may later be occupied by termites, so that the treatment is only temporary. Paris green sprinkled in the runways

will kill termites that eat it, and their bodies are, in turn, eaten by the living ones remaining, so that the poison may do duty several times over.

Certain treatments for wood have been devised, which are intended to render it immune to attack, and these treatments are usually successful as long as the impregnating oil remains in the wood. Fortunately, there are some kinds of tropical woods that are so hard and dense that termites will not attack them. These woods have long been in demand for important structures, and are consequently scarce and expensive. The most obvious method of preventing loss from termite activities is to build structures of materials other than wood. Masonry and steel are the two termite-proof materials most easily obtainable, so in tropical countries it may eventually be economical to build of these materials rather than of wood.

KAWAIAHOO CHURCH, HONOLULU, BUILT IN 1839
Made of Unplastered Coral Reef Stone Block Laid with Lime Mortar
Lime Made from Burned Coral

TROPICAL STORMS ARE SEVERE

The violent tropical storms, which are generally cyclonic, may be expected to occur in the summer rather than at other times of the year. Their cause is to be looked for in the heating of the air over a continental land body, with a resulting inflow of air from the adjacent water-covered areas. Since to this is added the tendency of the trade winds to flow in an east and west direction, the most violent of the tropical storms are to be expected on the eastern coasts of large land areas. The typhoons of the Asiatic Pacific Coast originate several hundred miles out at sea—apparently in the general vicinity of Guam—and move westward to the coast of Asia, just as the West Indian hurricanes originate to the east of the Caribbean Sea, and move toward the coasts of Mexico, Florida, or the Gulf States. In such cyclonic storms the velocity of the wind in the whirl may be very great, 100 miles per hour being not uncommon, but the forward movement of the whirl itself may be comparatively slow. These tropical storms are sometimes accompanied by very heavy rainfall.

It has been customary to design steel frame buildings for sugar mills in Formosa and the Philippines to resist a wind pressure resulting from a velocity of 100 miles per hour. Wind velocities of this order occur in these localities almost yearly. It has long been realized that the Philippines occupy a stormy section of the earth's surface, yet they are not much more exposed than is the adjacent coast of the Asiatic mainland.

Repair work during a tropical storm is often out of the question. If a railway embankment is washed out, this work is usually postponed at least until the wind abates. The tropical seasons are generally spoken of as the "dry season" and the "wet season." There are some tropical lands in which there is a scarcity of rainfall, but in most of them rain is likely to be concentrated largely into a few months of the year. During such periods, out-of-door engineering work is seriously handicapped. Transportation is made difficult—excavations fill with either rain or groundwater or both—and a certain amount of sickness will result if men work out in the rain.

Tropical agriculture nearly comes to a standstill during the wet season, as animals become mired in the fields and transportation over open country is practically impossible. Construction work, which has advanced enough to be done under cover, may be continued during the rainy season without delays. Road maintenance during this period is reduced to the minimum necessary to keep the roads open, if this is possible. The likelihood of earth and rock slides increases with the saturation of the soil during the wet season, and if a road is located on a side hill it may be blocked by slides which are difficult to remove before comparatively dry weather sets in.

The advisability of locating mountain roads in tropical lands on ridges rather than in valleys has been pointed out by Warren D. Smith in his "Tropical Geology and Engineering" (*Philippine Journal of Science*, March 1921). The particular example that he cities is a comparison of the Benguet Road to Baguio, which lies in a mountain gorge, with the Naguillian Road, which is in general located on ridge summits. Although the Benguet Road is one of the world's scenic highways, it was expensive to build and is also expensive to maintain.

In connection with highway maintenance, the tropics have one great advantage over the colder regions, in that there is no frost to heave the ground. This advantage is probably offset, however, by the trouble of maintaining road surfaces where the rainfall is excessive. Gutters scour out, pavements are undermined, and the laterite which underlies a pavement will alternately swell and shrink, first heaving and cracking the pavement and then leaving hollow spaces beneath it.

Using Burned Clay Masonry

Manufacture of Clay Products and Investigations of Their Characteristics

By F. E. Emery

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Archaeological discoveries of baked and burned clay in the form of pottery, terra cotta, ornaments, and specimens of clay masonry, which have existed for thousands of years, testify to the fact that properly treated clay is one of the most enduring of all materials. The manufacture of modern hollow-clay tile fireproofing began in England, and its use became general in this country after the Chicago fire. In this paper, Mr. Emery briefly explains the processes of mining clay and of manufacturing it into brick and tile and the features of the design of masonry construction. While this field has been investigated by both the Government and educational authorities, it has not been exhausted and it still, according to Mr. Emery, presents interesting and unusual opportunities for the masonry engineer.

Clay, which was formed in early geologic history before life appeared on the earth, is a product of decomposed rock chiefly made up of hydrous aluminum silicates, with varying quantities of other minerals and some varieties of organic matter. Clays may be classified according to their geologic occurrence as: primary, or those appearing in the places where they were originally formed; and secondary, or those transported by water, chemically changed, and redeposited. The secondary group were washed by rains into streams where they were chemically changed and purified. Then they were transported and redeposited in quiet pools in ancient lakes and seas. After the passage of ages and the emergence of continents from the sea, some of these ancient deposits were found to have turned into clay beds. Heavy forests, which frequently grew in these beds, later changed to coal, thus accounting for the fact that clay is often found beneath coal seams.

Burned clay products have innumerable uses as, for instance, inclosing buildings of every description, from small dwellings to the largest skyscrapers. They are also used in the building of partitions, fire walls, and chimneys, and in the fireproofing of structural members. In the form of paving brick, they make an excellent wearing surface for streets and roads. Fire brick are used for the lining of fire boxes in boiler plants, locomotives, and other places where a high heat-resistive material is required. Among other important clay products are burned clay conduits, which carry the electric cables and telephone and telegraph wires of the country; porcelain, which has almost countless uses; sewer pipe; and hollow tile for drains.

Structural clay tile is also used in combination hollow tile and concrete floors for both one-way and two-way systems. Tests made at the Bureau of Standards show that the hollow clay tile adds to the strength of such floors, and should be included in calculations involving both shear and bending. The Government uses this type of floor extensively, and many large buildings, with combination clay tile and concrete floors, have recently been built in New York and other parts of the country.

Clay brick is one of the earliest building materials on record. In ancient times both sun-dried and kiln-burned masonry materials were used, and walls were often built of sun-dried brick faced with the fire-burned product. For many centuries clay masonry units were made about the size of the modern common brick, or sometimes a trifle larger. Early attempts to make them in slabs were unsuccessful because of the difficulty of burning large masses of solid clay.

About the middle of the eighteenth century, however, an Englishman found that larger units might be burned without warping if a hole were put through them so that the mass would dry and heat from the inside and the outside at the same time. This discovery resulted in the development of hollow burned clay masonry units, which have been closely allied with the advance of fireproofing and modern building practice.

It is believed that the first large structure in which hollow tile was used for fireproofing was the Liverpool Cotton Exchange, built about 1870. In 1871 the great Chicago fire paved the way for the rapid advance of modern fireproof construction in the United States, and from that time until the present structural clay tile has been widely used. Special designs are made to fit various structural steel shapes, and to fill between steel floor beams in the form of arches.

In this country, the first use of hollow burned clay units in bearing walls was probably in the Butterfield Flats in Utica, N.Y., designed by C. Edward Cooper, Architect, and built in 1886. One of the interesting features in connection with this building is that the idea of fireproofing was paramount in its design, fireproof floors being used throughout.

Structural clay hollow tile are burned ceramic masonry building units made from surface clay, shale, fire clay, or admixtures of these. Specifications as to

Clay Banks at Perth Amboy, N.J.

quality, workmanship, and marking are issued by the American Society for Testing Materials in the following three types: (1) structural clay load-bearing wall tile; (2) structural clay fireproofing, partition, and furring tile; and (3) structural clay floor tile. The specifications are used by the Government as the standard for classification and construction.

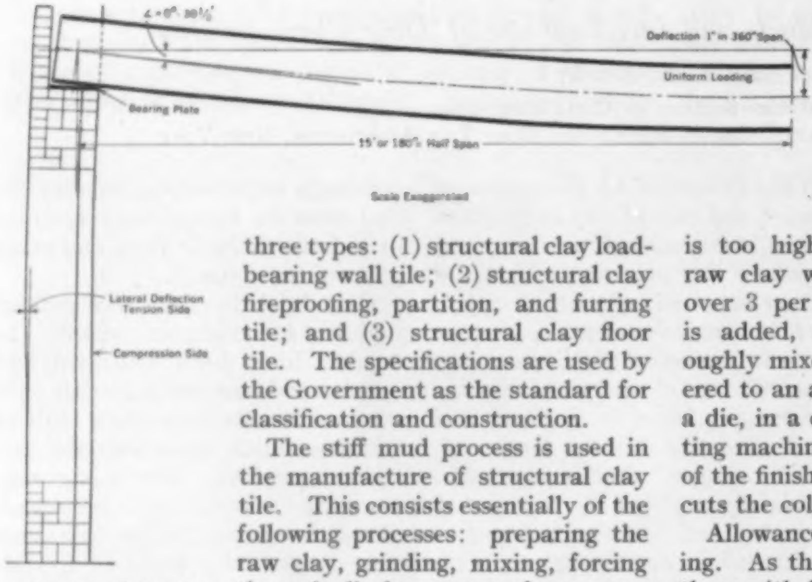


FIG. 1. BEAM DEFLECTION CAUSES ECCENTRIC LOADING

The stiff mud process is used in the manufacture of structural clay tile. This consists essentially of the following processes: preparing the raw clay, grinding, mixing, forcing through die by means of an auger machine, cutting to length, drying, and burning.

It must first be ascertained by laboratory tests that clay deposits do not contain injurious properties, such as iron, lime, magnesium, or alkali, in harmful quantities, which would greatly reduce their refractoriness, and that the desired plasticity may be developed. The reason for this is that clay must dry rapidly without excessive shrinkage or cracking, and it must be capable of being burned to the desired texture and strength. When it has been determined that the deposit contains the proper chemical compounds, it is either dug by hand or by power shovel from very near the earth's surface. However, if the overburden is too great, it is mined—sometimes from hundreds of feet below the surface. When the clay bed is found underneath a vein of coal, both the coal and the clay are mined at the same time.

As fire clay and shale are brought from the clay beds to the factory, much of the material is in large chunks, which must first be put through a grinder. This will break up the large pieces and crush the pebbles and laminated texture of the raw material. As surface clay is brought from the clay bed, it is passed through a machine called a "granulator" in order to break up the large chunks and separate the clay from large stones. It is then put through conical shaped rolls, which crush small, hard lumps of clay and soft pebbles and in addition throw out the large, hard stones.

After the material undergoes these preliminary processes, depending upon whether it is fire clay, shale, or surface clay, it is put in a mixing machine called a "pugmill." This consists principally of a chamber within which revolve one or two shafts with blades rigidly attached, and it thoroughly "pugs" or mixes the material.

In some clays it is essential to the process of manufacturing the raw product into masonry units to add "grog," or ground burned clay. This is used when necessary to help control shrinkage in burning and, in case the moisture content is too high, it takes up part of the excess. After raw clay with the required admixture of grog (not over 3 per cent) is delivered to the pugmill, water is added, if necessary, and the whole mass thoroughly mixed into a stiff, plastic mud. Then it is delivered to an auger machine which forces the mud through a die, in a continuous stream called a column, to a cutting machine. The die forms the shells, webs, and cells of the finished hollow tile units, and the cutting machine cuts the column into desired lengths.

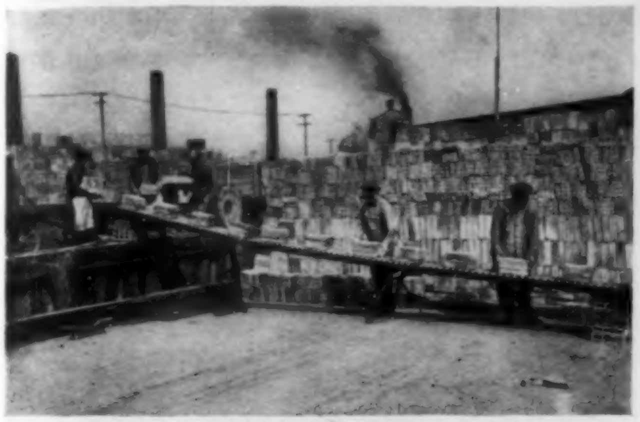
Allowance is made for shrinkage in drying and burning. As the units are cut they are carefully inspected, those with flaws being rejected and returned to the auger machine. Perfect units are loaded on small cars and sent to a dryer, where they are exposed to a current of heated air which absorbs most of the moisture. From the dryer the units are taken to the kiln, in which they are burned from 72 to 100 hours, the temperature being gradually increased up to 1,800 or 2,100 deg. fahr., depending upon the chemical properties of the clay.

TILE CUTTING TABLE AND CUT-OFF BELT
Inset Shows the Die End of the Auger Machine

The burning of clay is a highly technical art and it is

a separate study in itself, due to the difficult chemical conditions under which the raw clay is found. There are scarcely two beds from which the clay can be burned in exactly the same way. Also, during the process of burning, the temperature must be watched carefully so that the material will reach the proper degree of hardness without excessive warping or shrinkage. When the burning is completed, the kiln must stand for two or three days in order to cool sufficiently for the product to be removed. After the masonry units have been taken from the kiln, they are ready for the market.

Burned clay products can be given a very fine glaze or enamel of practically any color desired. Glazes are glassy coatings used for ornamentation or waterproofing, or for both. They belong, in general, to the silicate



Loading Finished Tile on Barge from Yard Trucks
Using Roller Conveyor

group of chemical compounds. The commonest form of glazing, known as the salt glaze, is done simply by adding salt to the fire as the ware is burned in the kilns. This gives a crystalline finish to the face of the units. However, a higher form of glazing is accomplished by spraying or painting the coating on the units before they are placed in the kiln, in which case any desired color may be added. Glazed structural clay tile is widely used for both exterior and interior surfaces of walls and partitions, as glazed finishes are entirely unaffected by such factors as moisture, dirt, grease, chemicals, or heat and cold.

The design of masonry in modern buildings is complicated and calls for specialized knowledge of various materials and systems of construction. It is only in comparatively recent years that engineering science has turned to the study and investigation of structural strength and physical properties of masonry construction.

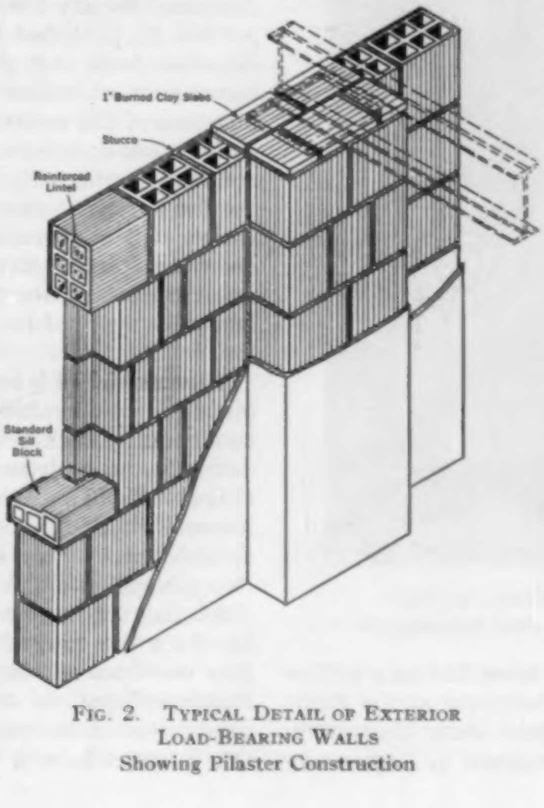


Fig. 2. Typical Detail of Exterior Load-Bearing Walls
Showing Pilaster Construction

For instance, even after the advent of the skeleton type of building, solid masonry panel walls continued in use. However, as buildings grew taller and resulting masses of masonry became heavier, hollow tile came into general use

Method of Laying a Stormproof Wall
Face-Brick Stretchers Laid and Pargeted with 1/2-In. Mortar
Before Laying the Brick or Tile Backing

to lighten dead loads and reduce the cost of structural framing.

In spite of this fact, there were few scientific data available for even the simplest unit masonry design. The steel and cement industries were far ahead in this respect in that there were formulas for the design of steel and concrete structures, but there was practically nothing for masonry construction. About 20 years ago, the hollow tile industry, realizing this deficiency, began an extensive research, which is still being carried on. The clay brick interests have also carried on extensive research. Numerous reliable data on structural clay masonry materials are now available as a result of the researches which have been conducted at the U.S. Bureau of Standards and at the engineering experiment stations of various universities.

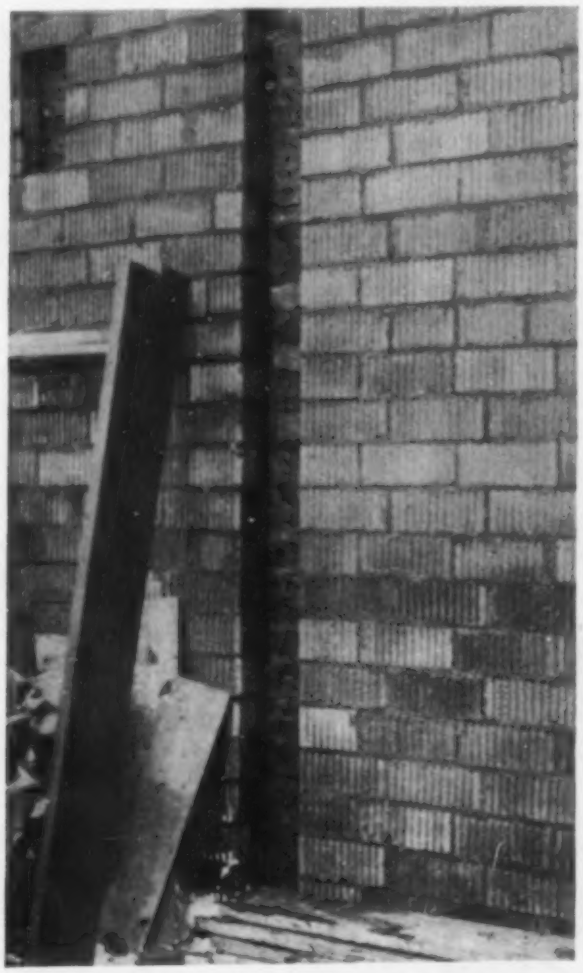
Bulletins issued by these authorities include data from which structural strength, fire-resistance value, and resistance to transfer of heat, cold, sound, moisture, and other properties may be determined. The compressive and transverse strength of structural clay tile walls is described in the Bureau of Standards *Technologic Paper No. 311*, which shows the results of tests on 70 hollow tile walls constructed under ordinary working conditions. These walls were 6 ft. long, 9 ft. high, and from 8 to 12 in. thick. There were 14 different lots of tile and 4 different mortar mixtures used in their construction. Of the 70 walls, 53 were tested in compression under

central loading, and 17 under eccentric loading. Before 27 of them were tested in compression under central loading, they were subjected to a transverse test.

Research Paper No. 108, on the compressive strength of clay brick walls, also issued by the Bureau of Standards, is very useful for masonry designers, as it gives results of tests conducted on 168 walls of common brick, each 6 ft. long and about 9 ft. high, and on 129 small walls for test purposes. There were 4 kinds of brick, 3 mortar mixtures, 2 grades of workmanship, and 10 types of masonry tested. Curing conditions were also studied.

In actual construction work, nearly all loads on masonry walls are eccentric. However, in most instances, designs are made on the basis of concentric loading. For example, the ordinary allowable deflection of floor and roof beams resting on a pilaster is $^1/_{360}$ of the span which produces an angle under the bearing end of the beam. This condition is shown in a somewhat exaggerated form in Fig. 1. This is the usual condition of loading in practice, although such loads have as a rule been computed as in direct compression on the wall. In Fig. 2 is shown a detail of the construction of a bearing wall.

To determine just what effect the eccentricity result-



PIPE CHASES IN STRUCTURAL CLAY TILE WALL
Chases Should Be Built into the Masonry

ing from the deflection in a loaded beam had on a wall or pilaster, special tests were made last year at the Engineering Experiment Station of Ohio State University. The results of these researches are given in *Engineering Series Bulletin No. 57*, of Ohio State University Studies. It is believed that these are the first tests ever conducted with special apparatus to duplicate varied eccentric loading, such as that produced by the increasing deflection of a floor beam as the load is increased.

In the design of walls, fire-resistance values are very often of prime importance. As a rule, the exterior walls of structures in cities must be built to resist fire for certain definite periods, and large buildings are further subdivided with fire walls running from the base to above the roof. Fire-division walls are often used as partitions to divide floors for special occupancies. In many cases, party walls are required not only to resist floor and roof loads, but also to have a fire-resistance value. To determine the fire-resistance value of brick and hollow tile walls, and combination walls of hollow tile and brick, a great many tests have been conducted at the Bureau of

MASTIC-SATURATED MEMBRANE FOR WATERPROOFING
At Spandrels and Window Heads

Standards. These have been undertaken in accordance with the standard fire-test specifications issued by the American Society for Testing Materials. *Research Paper No. 37*, published by the U.S. Bureau of Standards, describes tests and gives fire-resistive values of walls constructed of hollow load-bearing wall tile, and combinations of this material built with brick.

Other fire tests were made at Ohio State University on non-load-bearing walls of structural clay tile to determine the fire-resistive value of interior non-load-bearing partitions. It was discovered, for example, that a 4-in. non-bearing wall, plastered on both sides, would resist a standard fire test for $1^1/_2$ hours, and that a 12-in. bearing wall, plastered on both sides, would resist a 7-hour fire test.

The transfer of heat or cold through building walls is often of considerable interest to designers, and tests have recently been made by the Bureau of Standards to determine the resistance of various materials to transfer of heat and cold. The results, charted and published as *Research Paper No. 291*, show that, from the standpoint of resistance to transfer of heat and cold, structural clay tile walls are high on the list.

Another subject for study at the Bureau of Standards has been the transmission of sound through wall and floor construction, the results having been published as *Research Paper No. 48*. Many of the walls tested were constructed of hollow tile and show that partitions of this material have a high efficiency. One of the prin-

ciples established through these tests is that the capacity of a wall to resist transmission of sound is almost directly proportional to its weight. In other words, a thin sheet of steel and a thick sheet of fiber board, both of the same weight per square foot, would transmit sound equally well. As far as homogeneous walls are concerned, there is no superior sound-insulating material. In fact, to obtain satisfactory sound insulation when interior partitions consist of homogeneous walls, would involve walls of prohibitive weight and cost. However, good results can be obtained by the use of an air space. This explains why walls built of structural clay partition tile,

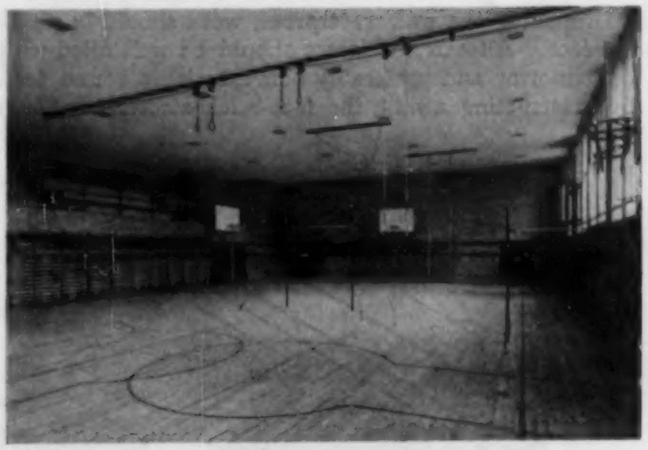
Vitrified Tile Wall for Sewage Treatment Plant
Westchester County Sanitary Commission, South Yonkers, N.Y.

providing an air space of at least one or two cells in the thickness of the wall, are as soundproof as is compatible with considerations of weight and cost.

The difficult problem of building stormproof walls has received a great deal of attention during the past few years. The causes have been studied, and many cures considered. Extensive research has been conducted at the Bureau of Standards and other accredited institutions. While investigations have not yet been completed, the results so far obtained indicate that leaky walls are preventable, if consideration is given to the quality of the clay masonry units, of the mortar, and of the workmanship.

With the advent of portland cement, the use of mortar rich in cement was advocated on the ground that it produced walls of somewhat greater strength. For a time this was considered the most important property of a wall, but later it was realized that there were other important factors to be considered in exterior walls. One of the first is the ability to withstand penetrating rains.

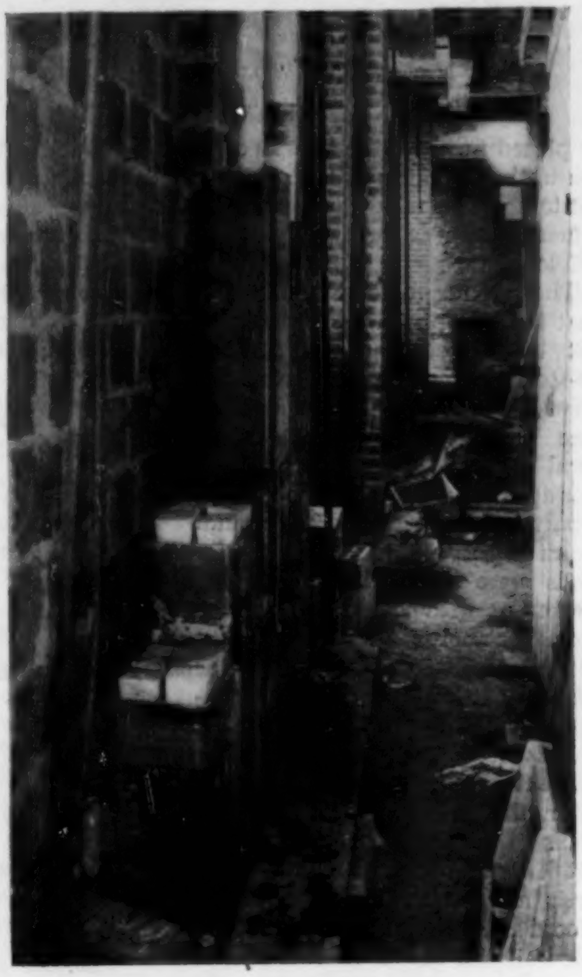
Investigations of leaky walls indicate that, while rich cement mortar will produce walls of slightly greater crushing strength, it will, subsequent to hardening, undergo greater expansion on wetting, and greater shrinkage on drying, than will mortar of a high lime content. The greater volumetric change in rich cement mortar than in masonry units tends to break bond and cause cracks, through which water can easily penetrate. This has been found to be one of the most frequent causes of leaky walls. Preliminary investigations made on this subject have been fully described in *Research Paper No. 290* of the bureau ("Durability and Strength of Bond Between Mortar and Brick"), and *Research Paper*



Tile Walls in a Gymnasium
Y.M.H.A. Building, New York

No. 321 ("Volume Changes in Brick Masonry Materials"). Masonry designers, in particular, will find these reports instructive.

Another reason for recommending mortar of a higher lime content is that it is more workable and that masons



Clay Conduit Tile for Riser Cables
Telephone and Telegraph Building, Fire Stations, Power Houses

are consequently more likely to get the joints well filled, which is very important for stormproof walls. Lime also produces a more flexible mortar so that slight movements, due to vibration, are not so apt to cause cracks.

In making the wall waterproof, work should begin at the face. All exterior joints should be well filled with good mortar and preferably pointed with a round tool. In constructing a wall, the face-brick stretchers should be placed first and their backs carefully pargeted before the back-up units are laid. If this is done and the joints are well filled with good mortar, not too rich in cement, there is practically no danger that the walls will leak.

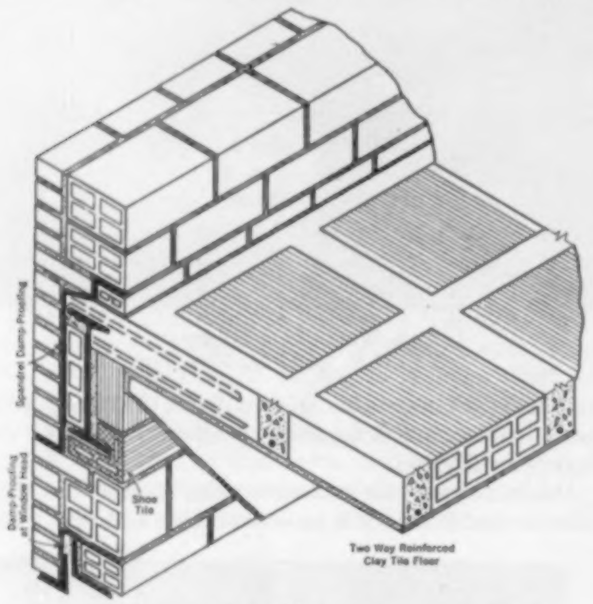


FIG. 3. HOLLOW TILE WALL FACED WITH BRICK
Method of Fire-Proofing and Damp-Proofing

The importance of using mortar that is not too rich in cement cannot be overemphasized. In one 70-story building recently erected in New York, the walls were built of face brick, backed up with structural clay tile. The mortar used was approximately 1 part of cement, 1 part of lime, and 6 parts of sand. In an adjacent building, the exterior walls were built with face brick, backed up with common brick; and mortar, composed of 1 part cement to 3 parts of sand, was used. The first of these two buildings is storm-proof, but the second leaks badly, and it required great expense to make it waterproof.

Another necessity for water-tight walls is flashing, which should be properly applied to all roofs, spandrels, and window and door heads. Roof flashing should extend through the wall just above the roof line, to prevent water which enters the parapet from running down into the masonry work below. In addition, all spandrels and window heads should be fully waterproofed, as is shown in Fig. 3, and all window and door frames should be carefully caulked with elastic caulking cement. A coat of mastic, from $^1/_{16}$ to $^1/_8$ in. in thickness, mopped or troweled on the inside of the wall, is used extensively and is effective in preventing dampness on the inside of the wall, resulting from capillarity.

Furring the inside of exterior walls is a feature of good construction, and should always be done on solid masonry. However, in many large buildings constructed of face brick and backed-up with hollow tile, no furring is used. The air spaces in hollow tile units have practically the same effect as furring. And when such walls are properly constructed, as has been described, with the inside well coated with mastic, very satisfactory results are obtained.

Although there is at present a lack of coordination in the size of masonry materials, a standard unit of dimension for masonry is being advocated. It is believed that many difficulties could be overcome by the adoption of such a standard unit to be used by architects and engineers in dimensioning buildings and by masonry material manufacturers in determining the size of their products. This would simplify the design of wall systems, as some of the producers of wall materials have adopted independent standards. Brick manufacturers often consider it good business to make over-sized brick, and to sell them at the same price per thousand that their competitors sell the standard-sized product. The contractor who buys these over-sized brick labors under the impression that he is saving money. In reality, he pays a premium, as the cost of labor is higher when these brick are used with other masonry units which have been worked out according to the standard unit of measurement. Furthermore, this procedure is apt to result in poor workmanship, which is detrimental to the structure.

Since masonry work forms such a large part of almost every building, it should be given the most careful scientific attention. The same principles of design that are used in the other structural and mechanical features of a building should be applied to it. There are many excellent examples of good masonry construction, but too often this work is done in a haphazard manner. Conditions and materials vary in different parts of the country. However, there would be fewer examples of poor masonry construction if allowance were made for such varying conditions and materials. Masonry units and mortar materials should be studied, and the best combinations worked out for their particular uses. These are opportunities for the specialized masonry engineer, and it is encouraging to note that many schools of engineering are paying more attention to this very important subject. Practically the whole field of research into clay products is open to the young engineer.

GOVERNMENT PUBLICATIONS ON MASONRY CONSTRUCTION

Those interested in a further study of masonry construction may obtain the following papers of the U.S. Bureau of Standards from the Superintendent of Documents, Government Printing Office, Washington, D.C.:

- *Technologic Paper No. 311, "Compressive and Transverse Strength of Hollow Tile Walls."* . . . . *15 cents*
- *Research Paper No. 108, "Compressive Strength of Clay Brick Walls."* . . . . *30 cents*
- *Technologic Paper No. 291, "Tests of Hollow Tile and Concrete Slabs Reinforced in One Direction."* . . . . *25 cents*
- *Research Paper No. 48, "Transmission of Sound Through Wall and Floor Structures."* . . . . *10 cents*
- *Research Paper No. 37, "Fire Resistance of Hollow Load-Bearing Wall Tile."* . . . . *75 cents*
- *Research Paper No. 321, "Volume Changes in Brick Masonry Materials."* . . . . *10 cents*
- *Research Paper No. 181, "Tests of Composite Beams and Slabs of Hollow Tile and Concrete."* . . *15 cents*
- *Scientific Paper No. 526, "Transmission and Absorption of Sound by Some Building Materials."* . *15 cents*
- *Engineering Series, Bulletin No. 57, of Ohio State University Studies, issued by the Ohio State University, Columbus, Ohio* . . *$1.00*

Highway Grade Separations

Engineering Preliminaries for Joint Municipal and Railroad Solution of Dangerous Traffic Hazards

By H. A. Shuptrine
Associate Member American Society of Civil Engineers
Bridge Engineer, Board of Wayne County Road Commissioners

So many interests are involved in any projected grade crossing elimination that no little effort is required to bring all concerned into agreement on a common plan. Usually the railroad and the municipality—state or city—are most actively interested. In addition, abutting property owners or industries served by the railroad must be considered. State laws may be involved on future city planning developments. The resulting studies are never simple; in some cases these preliminaries alone are responsible for almost endless conferences. In fact, they are considered to be half or more of the total task. It is with the important negotiations which lead to final agreement that Mr. Shuptrine is concerned. The results of his wide experience in practical engineering diplomacy should be of great service to other engineers faced with problems of a similar nature. This paper was originally presented before the 1931 annual meeting of the Michigan Engineering Society, at Saginaw, Mich.

During the past seven years, the Board of Wayne County Road Commissioners has initiated a program of grade separations in and around Detroit, Mich., which is worthy of record. Including those completed and under construction, there are now 55 separations on its highway system. Of these, 8 are separations of grades at highway intersections, and 47 at intersections of railroads with highways. The cost of the individual projects has been from $50,000 to in excess of $1,000,000, and the type of problem has varied from the ordinary rural grade separation to the most complicated of metropolitan developments, involving negotiations and agreements with many agencies.

It is desirable that the capacity which has been built into these grade separations be appreciated. As a measure of that capacity, it is perhaps sufficient to say that a grade separation representing the average of all these projects would contain provisions for in excess of 5 railroad tracks and 55 ft. of paved highway through the separation.

It is no idle remark that when the steam shovel begins to dig, the grade separation is half done. In fact, from the point of view of time consumed, difficulties overcome, and importance in the ultimate project, the undertaking is 50 per cent completed even when it is released to the draftsman for detailed plans. It is with the municipal engineer's efforts on this first essential half of a grade separation job that this article deals.

Although the railroads have capable engineering organizations to consider and work out plans for such construction, it is usually necessary for public authorities to take the initiative in grade separation projects. In so doing it is essential that they be represented by engineers just as capable as those who serve the railroad. Such engineers should be able to handle all phases of the problem.

Considerable experience in such work brings a ripened judgment and an appreciation of the interests and problems of all concerned, which will go far toward foreseeing and avoiding, or toward solving, the difficulties involved in reaching an agreement.

In the absence of such capable engineering counsel, public authorities are apt to try to accomplish their purpose by coercive measures, and by resorting to the methods provided by law for forcing the railroads to accede to demands for specific grade separations. Although it is perhaps necessary that such laws be enacted, it is unfortunate when they are resorted to. In general, quicker and better results are obtainable through negotiations between capable representatives.

Agreement the Main Aim of Negotiations

Negotiations have a habit of winding up in an argument unless the principals bear in mind that the goal is an agreement and not a disagreement. Since the negotiations are usually initiated by, or on behalf of, the public authorities involved, it is essential that those in charge for the public always steer toward an agreement. Attention to a few salient points will aid the negotiator.

1. Do not spring ultimatums.
2. Keep a fair-minded attitude toward the other man's angle of the problem; if there were only one side to the question negotiations would not be necessary.
3. Avoid closing your avenues of retreat from any position taken.
4. Make each conference result in some definite step, however small, toward an agreement.
5. Keep on the alert to grasp and meet the other man's argument, and to aid him in understanding your own point of view—sometimes he is right!
6. Remember that as surely as you must justify the solution to your principles, just so surely must he justify it to his.
7. Be tenacious without being pugnacious; but be ready to retreat from a position when sure you are wrong.
8. Do not rely on precedents, and avoid the tendency to set them up. Rather, let each problem rest on its own merits. Often a clear statement of the premises involved will bring about an agreement.
9. Even though you are defeated, shake hands and smile after each conference. No matter how much you may differ with another negotiator, do not let your differences become a personal matter—you may be required to deal with him again.
10. Be willing to give ground if you want the other man to do likewise. There can be no taking without giving. Do not let some comparatively minor element of plan or cost interfere with the solution of

the major problem—which is the separation of grades.

Within reasonable limits, the determination of, and agreement on, the best plan is more important than the finding of the cheapest plan. It may be necessary to develop several schemes and estimates in order to discover the most economical one and to prove that any difference in cost between that and the desired plan is warranted. Particularly in or near large cities, it is of the utmost importance that adequate provisions be made for the ultimate future of the highway. It is equally important that the future of the railroad be sufficiently provided for.

GRADE SEPARATIONS AT MICHIGAN AVENUE, DEARBORN, MICH.
Note Center Piers and Arcaded Sidewalks

If, through a penny-wise policy on the part of one or both of the interested parties, a structure is built which takes into account only the present width or the present needs of the highway, the grade separation will become merely another ordinary street, and sooner or later, as the territory is platted or developed, it must be supplemented by other crossings at every block.

While it is sometimes feasible to build the structure in such a manner that it can later be expanded as the arterial character of the highway develops, I believe that cases in which such a plan is advisable, particularly in metropolitan areas, are rare.

In the first place, the widening or other enlargement of these facilities at a later date can be accomplished only at a greatly increased cost per unit of comparison. This is particularly true of subways. Secondly, it is usually difficult to find time or money for such enlargement—the desire is for additional structures and therefore the money available is usually spent at new locations. In the third place, the arterial character of the highway will not have been clearly evident in the meantime and its effect on adjacent developments will therefore be more remote.

RIGHT-OF-WAY SHOULD BE GENEROUS

The first step in providing arterial possibilities and characteristics for a highway is to secure the additional right-of-way needed for its utmost future development. The usual width of right-of-way on section-line and other existing roads is 66 ft. Where the highway is depressed through a subway, either expensive retaining walls must be built along the property lines, or additional property must be acquired and side slopes built.

Often the expense of these retaining walls and the abuttal damages incurred through their use will exceed the cost of land for neatly sodded side slopes by an amount sufficient to more than cover the additional cost of a much wider structure and right-of-way.

Sometimes, however, there is opposition to the condemning of property for side slopes. If in such cases the municipality has, like Wayne County, determined upon a master plan which designates the future widths or rights-of-way of all such highways, it is comparatively easy to condemn even locally to this width. Usually an adequate grade-separation structure can be made sufficiently narrow to permit side slopes within the right-of-way.

The public interest demands that just as serious consideration be given to the future needs of the railroad as to the highway plan. Sometimes there is a conflict of interests which may require a compromise in this plan. Forgetting other elements of the problem and reducing the matter to an absurdity for the purpose of argument, there can be no question that, from the point of view of maximum highway capacity and safety, the entire right-of-way should be spanned by a single bridge. This is often absurd, and a compromise is therefore practically always involved, such as center or side piers.

Undoubtedly piers in the paved area of the roadway introduce an element of danger. However, the closer the structure is to the developed sections of a metropolitan district, the less is the objection to intermediate piers, from the standpoint of highway safety, provided their presence is compensated for by additional width in the street and structure.

Elasticity of the plan of a subway as it affects railroad development may indicate the necessity for a deck structure of such detail that railroad tracks, crossovers, and ladders can be placed anywhere on the bridge or that a change of location of tracks can be made on the structure.

Under city conditions, the distance from base of rail to underclearance of a railroad bridge over subways is a controlling feature of plan and design. It is this factor which prohibits the use of deck structures for long spans even though they might otherwise be desirable.

In such situations it is also difficult to spread the railroad tracks from their standard centers. Thus the use of through structures for long spans is usually prohibited. Furthermore, from the point of view of safety to railroad employees, it is not desirable that any part of the structure should rise above the base of rail or, at most, above the top of rail. Consequently, in such territory it is almost always necessary to consider limitations of span in order to permit either deck or "semi-through" construction.

When the depth of ballast, thickness of concrete slab, and depth of structural floor supports are taken into con-

sideration, the use of semi-through construction will result in scarcely more saving in distance from base of rail to underclearance for spans up to 37 ft. than the deck construction method. However, the semi-through method of construction, without any appreciable increase in depth, is applicable to spans up to 45 ft. for the usual railroad loadings and details; whereas deck construction, due to the necessity of using built-up rather than rolled beams, requires much greater depths. These limitations imposed by design features are another reason why center piers must often be considered—particularly in the case of wider streets.

ADDED WIDTH AND HEADROOM REQUIRED

However, the introduction of a pier in the highway right-of-way immediately subtracts approximately 5 ft. from the width and also decreases the efficiency with which the right-of-way can be used for highway purposes. Suppose, for instance, that a highway 40 ft. wide between curbs, with at least a 1-ft. clearance from curb to other obstruction, is planned. The introduction of a center pier would require the availability of more than two 20-ft. pavements. It is probable that the equivalent of a clear 40-ft. pavement would not be secured short of two 28-ft. pavements or a clear width of 30 ft. between structural elements above the curb height. Similarly, the equivalent of a 60-ft. clear paved width would not be secured short of two 36-ft. pavements, or 38 ft. between obstructions above curb height.

In some cases, when a center pier is introduced, it may be possible to avoid additional piers at the curb line. If so, an expansion of the paved facilities of the highway can be obtained in the future, when desired, at a minimum expense by re-routing the sidewalks through pedestrian tunnels behind the abutments.

In Wayne County it is the practice to provide at least 15 ft. of clearance above the highway in subways. The limitations set by headroom may become an important factor as the uses of highways develop in the future.

The clearance of viaducts above railroad tracks is better standardized and is perhaps subject to less uncertainty in regard to future requirements. In some cases—particularly in built-up sections of cities and where the cost of a greater clearance would be a material factor—a minimum of 18 ft. is at present approved by the railroad. However, the standard clearance in Michigan is 22 ft., and in the opinion of the board every effort should be made to provide such clearance.

DRAINAGE AND PUMPING

In the flat land comprising Wayne County it is often difficult to secure natural drainage for subways. It is generally cheaper, in such cases, to construct an automatically operated pumping plant at the grade separation to lift the water to a practical point of discharge. The cost of such pumping plants, together with an estimated capitalized value for their maintenance and operation, should be included in the estimate. Even at a somewhat greater expense, it is advisable to secure natural drainage where it is reasonably practicable.

Although it is possible, from rainfall and run-off computations, to get a rough idea of the necessary capacity in such pumping plants, one should not rely too much on these computations. The extra cost involved in making the installation unquestionably adequate is negligible in comparison with the total cost or with the cost of damages and inconveniences which result from flooded conditions.

TYPICAL GRADE CROSSING ELIMINATION IN WYANDOTTE, MICH.
Side Drives Take Care of Abutting Property

In general, such pumping plants should include at least two automatically operated pumps so that, if one is out of order, the plant can still function. The usual installation for subways in Wayne County is either two 8-in. or two 10-in. centrifugal pumps, which are set at the bottom of the sump.

In size the sumps are usually large enough to take the capacity of the first onrush of a severe rain and give the pumps a chance to catch up. Usually they approximate 12 ft. by 16 ft. in plan and are 16 ft. deep below sidewalk level at the bottom of the subway.

INCIDENTAL COSTS SHOULD BE ANTICIPATED

Although an engineer may succeed in building a few projects on the basis of inadequate estimates, the difficulty of seeking additional appropriations will make the negotiator's progress more difficult in handling other projects with the same principals. It is better that there should be a small surplus after the project is finished. The plan must foresee any necessary provisions for maintaining highway and railroad traffic during construction, and the costs which are involved should be included in the estimate.

While provisions for maintaining highway traffic may not be a factor in the control of grade separation layout and plan, it may be that the provisions for maintaining railroad traffic will affect the plan. Railroad traffic is sometimes maintained by re-routing certain tracks as run-around tracks and, at other times, by carrying them on temporary bridges. In the second case, the necessity of erecting the permanent bridge without tying up the

The Superhighway Goes Under the Railroad
Highway Crossing in the Village of Allen Park, Mich.

railroad may impose definite limitations on the details of the structure.

Soil conditions encountered are often controlling features. In many Wayne County localities, for instance, the construction of a subway immediately involves the necessity of introducing struts under the roadway pavement between bridge foundation units. Sometimes a sufficient provision is obtained by constructing the pavement in two layers. The bottom layer may be a 10-in. reinforced concrete slab extending between all foundation units, and perhaps tied into such units. The top layer may be of concrete or some other type of wearing surface.

If soil conditions were more adverse, railroad bridge engineers would be loath to construct a subway unless the structure had the characteristics of a reinforced concrete box culvert of large dimensions. However, where an extreme skew is involved, even a concrete box type may be of questionable safety.

Choice of Viaduct or Embankment

In flat country a viaduct, considered as a substitute for a subway, is inherently objectionable from the highway standpoint. It is sometimes sarcastically referred to as a "man-made mountain." On the other hand, when the plan is considered as affecting a considerable area, it must not be forgotten that the expression, "Chinese Wall," used in reference to long railroad embankments involved in track elevations, is not without significance. Generally the practical solution of grade separation problems involves only partial track elevation or depression, the difference being taken in a corresponding change in the highway grade.

Since individual grade separations are costly projects, a general plan for separating grades over an urban area often defeats itself unless the plan is such that it permits piecemeal construction. A general plan of this nature is more practicable if it enables the study and construction of each crossing involved as a separate unit.

If the crossings to be preserved and separated are far enough apart, it may even be that a reasonable solution for each locality can be attained without interfering with possible future developments at the next crossing. A plan which approaches this solution can usually be financed by the community and the railroad involved. On the other hand, both the public and the railroad are likely to reject a general plan which immediately involves the expenditure of millions.

Questions of the division of cost between the interested parties, and the part of the total that should be considered as grade separation cost to be so divided, are inseparably connected. There is a constant tendency to set up formulas and rules in answer to such questions. From time to time, this tendency is reflected in laws or in precedents affecting future negotiations. And when such rules do gain a foothold, they make matters more difficult and complicated. In such cases, negotiators find it difficult to consider several possible plans for a project on their own relative merits. Each negotiator is necessarily influenced by the gain which will accrue to his principal by the application of such formulas. Thus he often finds himself diametrically opposed to the proper plan.

On the other hand, if no such limitations exist, it is usually possible for the negotiators to readily agree upon a plan acceptable to all and, with this decided, the problem of cost and division becomes much easier to solve. I have always set it up as a cardinal principle that the plan should provide adequately for the future of both the highway and the railroad and that the estimate of cost should be all-inclusive.

It is often claimed by one or another of the agencies involved that the only part of the cost of a specific plan which should be split is that covering the duplication of present facilities. The difficulty is that the advocate of this principle usually wishes to apply his rule to the plan agreed upon and does not wish to consider the matter in terms of what it would actually cost to duplicate present facilities under a suitable, but potentially more expensive, plan.

Who Should Assume Certain Costs?

The list of border-line items, which invite dispute concerning their inclusion or exclusion, in whole or in part, from the costs to be divided between the interested participants, is a long one. Among such items are the following: additional property for the highway right-of-way; additional property for the railroad right-of-way; header streets; closure of existing streets; paving of curbs and sidewalks in excess of those existing; reconstruction or relocation of publicly owned utilities; provision for more than the existing number of railroad tracks; new track work; more commodious railroad fills or cuts than those existing; preliminary planning; outlet to streets or properties otherwise cut off from access; conservation of present railroad access to ad-

A Major Revision in Detroit
Fort Superhighway Spans Three Railroads

jacent industrial developments; damages to property abutting on highways; damages to properties served by the railroad; cost of a bridge best suited to one agency as compared to some cheaper type advocated by another; relocations of railroad or highways in the interest of one or all concerned; reconstruction to remedy present-day needs of the highway or the railroad; and a grade separation at a new crossing, required either for highway or for railroad needs.

In some cases, damages to property abutting on the street are paid by the municipality, and the costs of rearranging railroad service to industries devolve upon the railroad or the industries. Under such conditions, it is natural that the municipality should be immediately prejudiced in favor of a plan for subways with track elevation and no appreciable depression of street grades. Grade separation damages mount rapidly in built-up areas if the street grades are materially changed.

However, both railroads and industries are in favor of a plan involving a minimum of change in the grade of the railroad. Thus the municipality and the railroad are immediately and diametrically opposed, and the stage appears to be set for years of dispute, with no grade separations in the interim.

Splitting the Costs

The grade separations law under which Michigan recently operated specifically stated what should be considered part of the cost to be divided, and specifically omitted certain other items from this cost division. Among the items omitted were property costs, damages, and highway detours. It further required an equal division of costs between the state and the railroad interests.

This closed specification or formula made negotiations very difficult in involved cases and tended to restrict the plan to something which the railroad must accept on an equal basis. While such a definite law may not cause any difficulty in the average grade separation, under strictly rural conditions, it does involve increasing difficulties as the state becomes engaged in city grade-separation problems.

Very recently the legislature revised the grade separation law under which the Michigan State Highway Department operates so that it no longer specifies what shall be included in the cost of a grade separation. Nor does it enforce an exactly equal division of costs between the public and the railroad interests. It also requires the state to recognize and compensate for abuttal damages.

Certain problems of this nature are not confined to the boundaries of a single municipality, and in many cases more than one railroad is involved. Any law which tends to specify a basis for the negotiation of such problems is not practicable in operation, as the utmost freedom in negotiation is necessary if the several agencies involved are to come to an agreement.

There are several general methods of dividing the railroad's share of the cost between two or more railroads involved in the separation of grades at a specific crossing. Assuming that the railroads jointly bear, say, 50 per cent of the whole cost, the most logical method is, perhaps, the following. Each railroad bears 50 per cent of the cost of the work on its right-of-way, and 50 per cent of the cost of all general work is divided equally among the railroads concerned. By general work is meant approaches, property costs, damages, and similar items which must be considered whether one or five railroads are involved. Sometimes, however, the 50 per cent of the cost of such general work is divided among the railroads either in the ratio of their right-of-way areas at the crossing or in the ratio of the number of tracks for each railroad for which provision is made.

The division of work between the interested agencies and the form of agreement are usually routine elements to be disposed of after a plan and a division of costs have been agreed upon. Often, however, if a carefully worded preliminary form of agreement is introduced when negotiations are near the final stage, it will help in solving the remaining difficulties.

In the absence of legal restrictions requiring exactness of the final result in division of cost, the agreement may be any of these three general types:

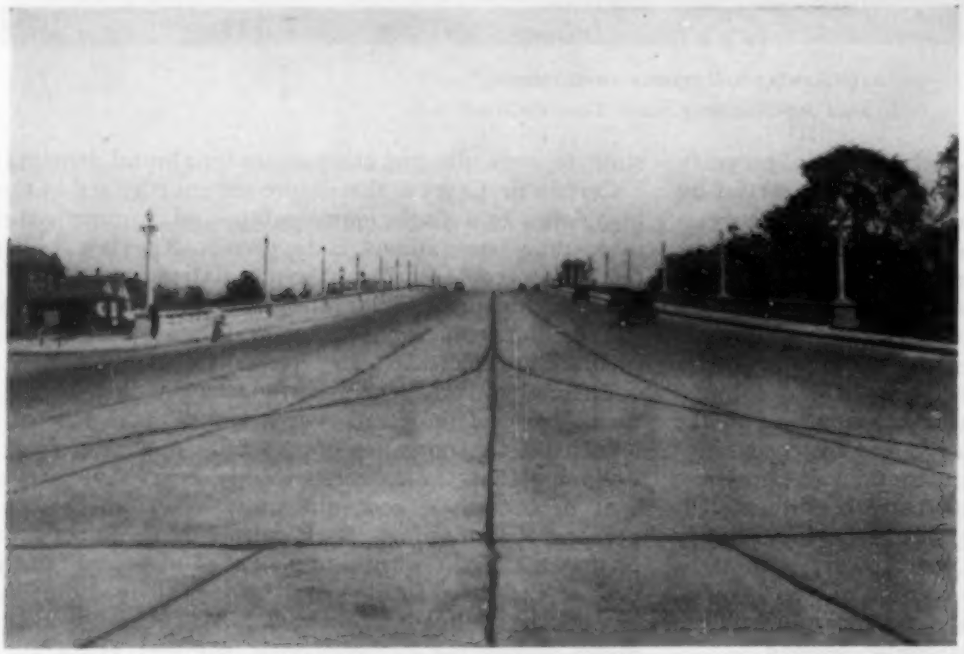
1. The "percentage agreement," in which division is by exact percentage of actual costs. In this case the agreement must set forth definitely not only what work is to be undertaken by each agency, but also exactly what percentage of its cost is to be repaid to such agency by each of the other agencies. It must also cover allowances for charges for overhead and administrative costs not directly allocated to the job, as well as credits for salvage.

2. The "lump sum agreement," in which division of costs is on the basis of a preliminary estimate which may or may not be made a part of the agreement. Lump sum values of the work undertaken by each agency under the terms of the agreement, as compared to the

lump sum representing that agency's agreed share in the total cost of all work, determine the amount to be written into the agreement as being paid by, or to, this agency.

3. The "division of work agreement," in which it is sometimes found practicable to divide the work involved so that the result will approximate the desired division closely enough to avoid the necessity for any exchange of money between the agencies taking part in it.

One law under which grade separations have been built in Michigan has already been mentioned. It applied to cities and villages of less than 16,000 population.



FORT SUPERHIGHWAY, DETROIT
Over Pennsylvania, Wabash, and Michigan Central Railroads

Another law, which applies to larger cities, is also applicable on county roads. This law gives wide latitude to negotiators in arriving at the terms of an agreement and sets up a method whereby the Public Utilities Commission may order the work ahead and divide the cost if an agreement is not negotiable between the agencies.

Perhaps the best feature of this law is that it recognizes damages to abutting property due to the change in highway grade and sets up the procedure for ascertaining these damages. The public authorities involved are obligated to institute, within one year after completion of the work, a suit in the interest of owners of such property to determine damages, and are also obligated to pay the damages so determined.

As a result of the fact that the owners are thus assured of payment for damages, any injunction that they may seek to stop the work will not be sustained. This is of utmost importance in and near cities where the resultant delays would be costly and where there are always owners who, for one reason or another, would like to stop improvements.

With the enormous increase in automobile traffic and in the development of road building programs throughout the country, the number of crossings where grade separations are needed is many times in excess of the eliminations. Furthermore, highway traffic, the great increase of which is the prime cause of so many grade separations, has become a serious competitor threatening the very existence of the railroads.

Painfully aware of this situation, the railroads are organizing to meet it by demands for legislation in all parts of the country that will require Government supervision of the bus and truck business comparable to that exercised over the railroads. These industries would then be obliged to adopt uniform accounting methods, report their operations to some Government agency, absorb a greater part of the tax burden, and submit to the fixing of their rates.

In the meantime, the railroads argue that it is unreasonable to expect them to be enthusiastic at the prospect of financing grade separations, which will improve the facilities of their competitors. These same competitors, moreover, pay only a small part of the cost of the facilities of roads, bridges, and grade separations.

In the long run, the entire cost of grade separations is borne by the public either in taxes or railroad rates. Hence, it seems logical that the trend of grade separation legislation should be toward requiring the municipal agencies to absorb a greater part of the cost of construction.

In order to aid in the construction of grade separations instead of retarding it, the legislation of the future should be broad. It should avoid the narrow and exact specifications which tend to circumscribe the engineer meeting the amazing variety of problems, conditions, and premises involved in plans and negotiations. If it is unavoidable that the percentages for division of costs be specified in such laws, no attempt should be made to define cost.

In several states, during the past year or two, the construction of grade separations has received an impetus from large issues of bonds. In such cases there is the temptation for both highway and railroad authorities to stretch the money available to cover as many constructions of crossings as possible and to finance many individual jobs without a due regard for the needs of the future.

As these mistakes are realized, the cost of correcting them will be considered a mutual obligation of the agencies involved in the original construction. There may be, at the present moment, a lack of legislation covering this problem of reconstruction. Undoubtedly, however, as the need for such legislation becomes more acute, it will be increasingly realized that the responsibility for mistakes and inadequacies is a joint one, whether the difficulty occurs through a lack of proper railroad or highway facilities.

This is a logical conclusion. In all grade separation undertakings, it is incumbent upon both agencies to consider the future.

Registration of Civil Engineers in California

By Donald M. Baker
Member American Society of Civil Engineers
President, California State Board of Registration for Civil Engineers, Los Angeles

FIFTEEN years of serious effort and struggle on the part of California engineers resulted, in 1929, in the passage of a bill providing for the registration of civil engineers. This bill became a law in the same year. Since that time, over 5,000 civil engineers have qualified under the new requirements, and certificates of registration have been issued. This brings to light the surprising fact that, for every 1,000 people living in California, there is a registered engineer. Since the enactment of this registration law, the following benefits have resulted: the civil engineers of the state have developed a professional consciousness; the mere existence of a registration board has been responsible for the discontinuance of certain unprofessional methods; and the practice of engineers who are unqualified and of persons who are not engineers at all, is rapidly being stopped.

THE subject of registration of professional engineers in California first came to my attention in 1917, when I heard a discussion of it at a meeting of the San Francisco Section of the Society. This discussion indicated that even then the subject had been under consideration for some time. It also revealed, as did later discussions, that the various engineering groups in California could not agree as to the proper phrasing of an act to be introduced in the legislature. At that time, strong opposition to the idea of registration was not presented. However, a great point was made of the necessity of drafting a perfect act before attempting to introduce it.

In 1922, the San Francisco Chapter of the American Association of Engineers appointed a committee to study the subject. This committee made a very exhaustive report, and a few days before the close of the first session of the 1923 Legislature I received from it a tentative bill with a request that I endeavor to have it introduced and passed. By the time the few necessary legislative contacts were made and certain objectionable features of the bill, from the legislative standpoint, had been eliminated, the first session had closed. Since each legislator is allowed to introduce only two bills during the second session and no member could be found who was willing to adopt this measure as one of his two, the effort collapsed.

NEW LEGISLATIVE APPROACH SOUGHT

A different plan of approach was adopted in 1925, when the situation again came up. A bill, patterned after the model bills proposed by the American Society of Civil Engineers and by the American Association of Engineers, was drafted by a small committee. Indorsements were then sought—not of the particular bill proposed, but of the principle of state regulation of the practice of professional engineering. This measure, which was widely supported by civil engineering groups throughout the state, successfully passed both bodies of the legislature but failed to receive the approval of the governor.

In 1928 the California Engineers' Registration Association was formed. The principal purpose of this association was to effect the passage of an act providing for the registration of professional engineers in the state and to support the administration of the act when passed. This organization attained a membership of approximately 1,000 engineers. At the request of this association, a bill, similar to the one introduced in the 1925 session, was brought before the 1929 Legislature. This bill had the indorsement of all the Local Sections of the Society in California, of all the chapters of the American Association of Engineers, of many local engineering societies, and of large numbers of individual engineers. However, some opposition arose from the mechanical, electrical, and mining groups.

The bill provided for the registration of professional engineers, but did not provide for qualification within the various branches of engineering. Experience in other states, as was brought out at conferences of the National Council of State Boards of Engineering Examiners, has shown that such segregation is impracticable. The insistence upon this feature, however, was so strong—particularly from agencies outside the engineering profession—that the bill was amended in committee to provide for it.

DEADLOCK CAUSES DIFFICULTIES

At this point, opposition arose among the civil engineers themselves, and a practical deadlock was reached in the legislative committee. Sponsors of the movement for registration felt that the first step in the right direction was to obtain statutory recognition of the principle, as in any event it would take time to produce a workable act. Since the civil engineering branch of the profession had furnished the primary support to the movement, the bill, as it was again amended and finally passed, provided for the registration of only practicing civil engineers. On August 14, 1929, the bill became a law.

It provides for a board of three civil engineers, to hold office for four years each, the first appointments being for two, three, and four years. These members, who are appointed by the governor, may be removed by him, but only when there is sufficient reason. They are paid $25 a day for time spent in attendance at board meetings and in service upon committees.

The "grandfather clause" of the bill, which was available only until June 30, 1930, required the following qualifications of an applicant for registration: an age of 25 years; good character; residence in the State of California for one year prior to the date of filing the application; six years practice in civil engineering as a professional business—one year of this to have been spent in responsible charge of work; and the usual credits for attendance at a recognized engineering school. Except

for elimination of the one-year residence clause, the requirements for admission to examination were the same. A fee of $15 must be paid when the application is filed, and from those who take the examination an additional fee of $10 is required. The annual renewal fee is $5.

Among the advantages of the act are the following: provision for reciprocity; guarantee of a seal for each registrant; and insurance for all plans and reports on public work in the shape of the supervising engineer's seal. The usual exemptions found in most acts are also provided. Certificates can be revoked, upon the receipt of a verified complaint and after a hearing, for fraud or gross incompetency in practice or for fraud or deceit in obtaining a certificate.

California now has a Department of Professional and Vocational Standards which acts for its various professional and vocational regulatory boards in all matters pertaining to investigations, accounting, and legal and clerical matters. However, the members of individual boards still retain full authority for the setting of standards, the conducting of examinations, and the issuance and revocation of certificates.

Shortly after the board commenced to function, it found a number of deficiencies in the act which have been remedied by amendments passed by the 1931 Legislature and approved by the governor. These deficiencies were as follows: no provision had been made for suspension of certificates; the grounds for suspension or revocation were insufficient; definitions of the terms, "civil engineering," "civil engineer," and "responsible charge of work," were not included within the act; there was no prohibition of soliciting practice or of the use of a title to indicate that the person employing it was a civil engineer; and there was no provision for practice by outside consultants called into the state for a limited period of time.

ORGANIZATION OF THE BOARD

The three members of the board were appointed October 14, 1929. At their first meeting, which was held on October 28, they organized as follows: Donald M. Baker, M. Am. Soc. C.E., Los Angeles, President; H. J. Brunnier, M. Am. Soc. C.E., San Francisco, Vice-President; Albert Givan, M. Am. Soc. C.E., Sacramento, Secretary; and Pecos H. Calahan, Assoc. M. Am. Soc. C.E., Glendale, Assistant Secretary. After organization, the first problem encountered was that of the adoption of by-laws, rules, and regulations. Other necessities were the establishment of a procedure for handling applications; the development of a definition of the terms "civil engineering," "civil engineer," and "responsible charge of work;" the establishment of proper standards for approved schools; and the compilation of a mailing list for distribution of forms and application blanks.

Other boards throughout the country were canvassed on the subject of their forms, practices, procedures, and policies. About one hundred letters were sent to outstanding leaders in the civil engineering profession throughout the country requesting assistance in arriving at a proper definition of "civil engineering."

Publicity was obtained both in the technical press and local newspapers. It was impossible to estimate the probable number of registrants. The board's first estimate, based on the best figures available, was somewhere between 1,500 and 2,000. However, 9,800 sets of application blanks were given out; and by July 1, 1930, the expiration of the time set for receipt of applications under the "grandfather clause," a total of 5,705 had been received. Application blanks and forms were delivered from the State Printing Office early in February, 1930, and the first applications were received during the latter part of that month. Of the total number received, 50 per cent came in during the month of June 1930.

The vast and unexpected amount of work faced by the board entailed an organization along lines of highest possible efficiency. The state was divided into three districts. Applications from each district were referred to the resident board member for review and recommendation to the board as a whole. The board then again reviewed the applications and took action. Several thousand letters were sent to applicants and their references requesting additional information; hundreds of personal interviews were held by board members; and many applicants were asked to appear before the board as a whole. The applicants grouped themselves into three classes: (1) those in regard to whose qualifications there was no question, (2) border-line cases; and (3) those whose qualifications were clearly insufficient.

RIGID QUALIFICATION NECESSARY

Because of the great interest aroused in the movement and the wide publicity given it, everyone even remotely connected with civil engineering seemed eager to register. The board was faced with many interesting and difficult questions, which, in most cases, resolved themselves into two problems: (1) whether the applicant had been actually practicing civil engineering or had been practicing something else; and (2) whether the applicant had actually had the necessary year in responsible charge of work.

In the first group came men who had been engaged in valuation work, city and regional planning, construction work, contracting, building design and construction, geology, and other branches of engineering. These groups of applications were gradually segregated. Applications from all the valuation men and all the contractors, for example, were put aside, and then each group was carefully investigated. Many of the applicants were then asked to appear before the board.

The final criterion adopted in each of these cases was that if a man had engaged in a certain kind of work through a civil engineering approach, this work was considered as qualifying him for registration. For instance, if it were found that a construction superintendent had received an engineering education, had had experience in civil engineering work, and then had gone into the construction field, it was considered that he was practicing civil engineering. If, however, he had entered the construction field from the labor ranks, working up to be a foreman, superintendent, or contractor, it was not considered that he was so engaged.

This test was applied to men in valuation and appraisal work, some of whom had entered the field with a civil engineering background, while others had entered it with a background of accountancy or construction work. Many of the men who applied had been in the building field but had not taken the examination of the State Board of Architecture. When their work indicated that they had been doing nothing more than rule-

of-thumb designing and that they had no knowledge of the fundamental principles underlying civil engineering, it was not considered that they met the qualifications. A similar ruling was made in the case of certified architects who did little structural design. If, however, the architect showed considerable experience in such design, he was registered. Contrary to what the board had expected, its largest task was not to require all men practicing civil engineering to become registered, but to exclude men who did not meet the qualifications set forth in the act.

LARGE NUMBER OF ENGINEERS IN CALIFORNIA

Data indicate that, outside of California, there are slightly over 20,000 registered professional engineers in those states requiring registration. This includes all branches of engineering. To date, slightly over 5,100 certificates have been issued in California. While it is true that a small number of these have been awarded to men who are primarily in mechanical, electrical, and mining fields, they have been issued only after a feeling of assurance on the part of the board that the applicant has had six years' practice in civil engineering, with one year in responsible charge of work, besides his experience in other branches of professional engineering.

Much was learned concerning the civil engineering profession in this state. A surprisingly high density of registered civil engineers with respect to population was discovered. California has 0.9 registered engineers per 1,000 population. However, if those who are now exempted in the estimate were included—such as employees of the Federal Government or subordinates—it is believed that there would be one civil engineer per 1,000 population in this state.

Feeling that it has a wealth of basic material in the professional biographies of these 5,100 civil engineers, the board hopes before long to be able to make a detailed analysis of these data. This would present, in a way never before realized, a true cross section of the civil engineering profession in one large state.

During the first months of 1931, the work on the "grandfather clause" applications was practically concluded. The board then gave its attention to legislative matters, to several requests for the revocation of certificates, and to the development of a policy in regard to examinations and administration of its work. It saw very clearly the high degree of specialization and the decided lack of knowledge of general fundamentals shown by many registrants. It attempted to devise a system of examinations by which the public could be assured that future registrants were fundamentally sound in their general knowledge of the profession. The plan provides for a three-day written examination, supplemented by an oral examination and the submission of a thesis or article on some subject of civil engineering accomplishment.

A syllabus, now being issued, describes in detail the scope of the examination, furnishes a list of textbooks and references which may be studied, and gives typical questions for the examination in fundamentals. The examination on the first two days will include questions on fundamentals in all the branches of civil engineering. On the third day, the examination will be devoted to the candidate's specialty. Furthermore, he will be required to submit a thesis or technical article upon some civil engineering work where he has acted in a responsible capacity, and also to appear before the board for oral questioning.

Graduates from recognized engineering schools are excused from the first examination, and any engineer who has attained a position of recognized prominence in his profession will be excused from the examination in his specialty. However, all candidates must appear before the board in person and must submit the thesis.

At present, the board is commencing to enter the administrative phases of its work. Two complaints have been filed asking revocation of certificates. A decision upon one has been reached, and the other is in court on a writ of prohibition brought by the respondent. No prosecutions have been made, although one was threatened in San Diego, where a layman contracted with the city to render civil engineering service. The board was instrumental in having this contract amended to require that such service be given by a registered engineer.

BENEFITS OF THE REGISTRATION SYSTEM

A question will naturally arise concerning the achievements of the period during which the board has been functioning. The following are the beneficial results:

1. A professional consciousness has been developed among the civil engineers in California such as never existed before. Now there are ten engineering societies in southern California—with membership in all of them open to civil engineers—presenting a united front on professional and public problems.

2. The board has, in an unofficial manner, settled many violations of the registration act by non-engineers and many breaches of professional conduct by members of the profession, where it did not seem advisable that official action be taken—because of the fact that the act was new and as yet not well understood, or because the violations were unintentional.

3. Relations between the professions of architecture and civil engineering have been placed upon a plane of close cooperation. Architects and engineers in California are marching arm in arm toward a common goal. At this time, tribute must be paid to both the California State Board of Architecture and the California State Association of Architects for their splendid spirit of cooperation and for the understanding of the common problems confronting the two groups, which they have shown during the existence of our board.

4. The mere existence of this board has had a very beneficial effect upon the public and upon the members of the profession. For instance, certain unscrupulous practices existing in the past have been abandoned since the formation of the board.

It will be far easier to talk of accomplishments after the act has been in operation five or six years than it is at the present time. However, it may safely be said that the board has a fairly definite long-time program. It has practically the unanimous support of the civil engineering profession in California, both individually and through its organization groups, and it is gradually attracting the attention and support of the public. It has endeavored to let intelligence, moderation, and practical sense guide its policies and actions, and the wisdom of this course has been amply justified.

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of everyday experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

De-Spiking Rails at Ten Miles an Hour

By H. Jackson Tippet
Member American Society of Civil Engineers
New Haven, Conn.

IN these days of change in the transportation industry from trolley to bus operation, those interested in track demolition might care to know more of a method of removing rails from ties, by a simple but very effective application of the wedge principle. So far as is known, the principle was first applied to this use only recently, by James J. Burns, of Detroit.

De-Spiking Appliance in Operation on Lines of the Connecticut Company at Hartford

The illustration shows a modification of the same de-spiking appliance in operation on the lines of the Connecticut Company at Hartford, Conn., where its adoption effected considerable economy in the spike-pulling operation over former manual claw-bar methods.

This device, which is used under each rail that is to be removed, might be termed a track ripper or drag. In this case, it consists of two 80-lb. A.S.C.E. standard rails set with bases about 12 in. apart. The rails are 15 ft. long over-all, with the forward end bent up for the first 3 ft. at an angle of approximately 15 deg., the better to engage and depress the ties. About 8 ft. from the front end, a short roller, 3 in. in diameter, is located across the top of the drag-rail heads; and to the rear of the roller, the drag-rails are reinforced and held together by bolting and by welded plates.

The de-spiking operation requires placing the rippers under the end rails of the track to be removed. The forward ends are then attached to a work car or train by a wire rope. As the car moves ahead, the rippers slide on the ties, the action de-spiking the rail, which then passes over the roller. In open track, the operation proceeds readily at from 6 to 10 miles an hour, depending on the quality of the ties. When some 18 or 20 rail lengths have been de-spiked in this manner, the operation is stopped and the first joint back of the rippers is broken. Then each length of 18 or more rails is hooked to the work car and hauled forward, as a unit, to the loading point, where the joint plates are removed and the copper bonds knocked out.

As the operation jacks up the track as well as de-spikes the rails, the ties are raised from their normal position in the roadbed, and are therefore more readily removable. This is a decided advantage when entire removal of the track structure is required. The field for this method of rail removal lies in track-abandonment projects, where the rapid salvaging of the rail from private right-of-way or from highway side location is the primary object, and where the facts that many of the ties still retain spikes and that the roadbed is disturbed are of minor importance.

In macadam pavement, the capacity of this device to remove shallow rails is only limited by the weight of motive power available. Rails have been satisfactorily removed from 5-in. bituminous macadam with the work car pulling the rippers alternately.

Built at nominal cost, the rippers have eliminated the obstacle of expense from rapid rail removal. The speed of the operation, with a work car and three men, is equal to from 500 to 800 ft. per min. How many trackmen with claw bars would be required to pull even 500 spikes in one minute?

Old Wood Pipe Stands Severe Test

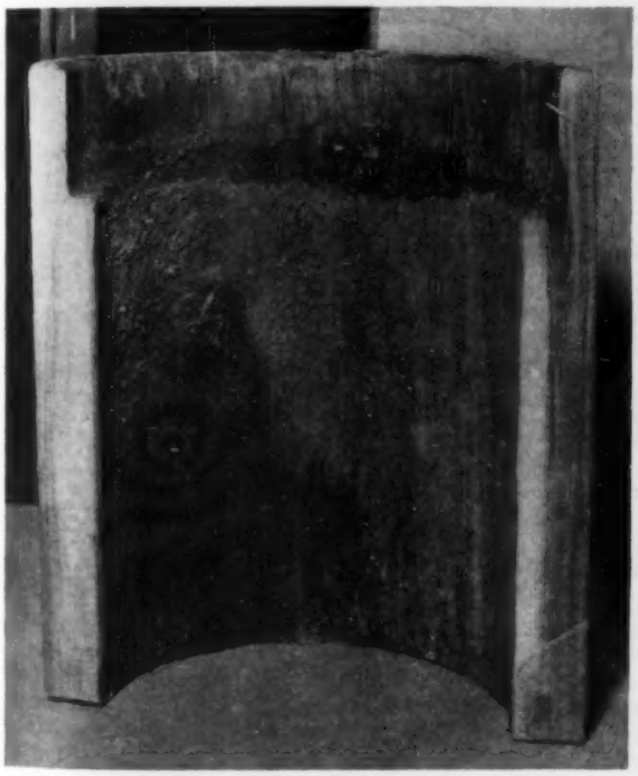
By F. W. Greve
Professor of Hydraulic Engineering, Purdue University
Lafayette, Ind.

THE durability of pipes of different materials is always a matter of interest to the hydraulic engineer, especially in view of the conflicting claims so frequently put forth by manufacturers of water mains for the lasting qualities of their respective products. Since many small

cities and towns are using wood mains that have been in service for many years, the question frequently arises as to the advisability of retaining such distribution systems in service or of replacing them with steel or iron mains. It is hoped that the tests described in this paper, which were recently conducted by J. Hedberg, Instructor in Hydraulics, and by me, in the hydraulic laboratory of Purdue University, will add to the fund of information on the subject.

Tests were made on two specimens of bored wood pipe—that is, tubes with solid walls. The material was white pine. The hydrostatic load was transmitted through the wall to a spirally wrapped steel band. When the asphaltic preparation thoroughly covering the exterior surface of each pipe was removed, it was found to have served its purpose so well that the bands and pipe surfaces were perfectly preserved. With the wall of each specimen $2\frac{1}{2}$ in. in thickness, recesses were cut in the ends—4 in. axially and $1\frac{3}{16}$ in. deep—to provide for the joints. The bands were $\frac{1}{16}$ in. thick by 1 in. wide.

Specimen *A*, with a 12-in. internal diameter and with bands spaced $1\frac{1}{8}$ in. from center to center, was furnished by the Water Department of Valparaiso, Ind. After 47 years of continuous service, during which it was subjected to peak loads of approximately 60 lb. per sq. in., the interior surface remained fairly smooth and firm except at the end of the recess, where the wood was soft and spongy. A longitudinal cut of the pipe showed sound wood to within $\frac{1}{4}$ in. of the interior surface.



Section of 12-In. Wooden Pipe
After 47 Years of Continuous Service

Specimen *B*, with a 10-in. inside diameter and with bands spaced $1\frac{1}{4}$ in. from center to center, was supplied by the Water Department of Union City, Ind. It had been in constant use since 1873, having been subjected to a maximum hydrostatic pressure of 90 lb. per sq. in. Considerable wear was indicated on the interior surface, which was rough and fibrous in appearance. It was stated that all sections of wood pipe removed from the system were similar in condition to the specimen submitted for test and that, although bad leaks occurred at some joints, they were probably produced by vibrations from railroad and truck traffic. The leakage appeared to vary directly with the atmospheric temperature.

Test Set-Up of 10-In. Wooden Pipe
Pipe 58 Years Old Tested at 150 Lb. per Sq. In.

The illustration shows Specimen *B* under test. Wood plugs, inserted in the ends of each specimen and caulked with oakum, were held in place by braces resting against concrete columns. Hydrostatic pressure was provided by a hand pump inasmuch as the regular laboratory equipment was incapable of producing pressures greater than 100 lb. per sq. in. Water was forced into the test specimen through a 1-in. pipe that penetrated one of the wood plugs. Two calibrated Bourdon gages measured the pressure. The hydrostatic load was then applied in increments of 5 lb. per sq. in. Excessive leakage around the plugs limited the pressure to 150 lb. per sq. in. Additional caulking had no effect because of the softness of the pipe wall, and the insertion of oakum beyond a certain amount would have increased the diameter of the specimens at the ends and possibly have caused rupture. It must be remembered that conditions at the joints, when the pipes are united in a single section, are quite different from those in the tests, and that therefore leakage will be produced in a different manner.

Specimen *A* was found to be safe for pressures up to at least 150 lb. per sq. in. Although several damp spots appeared on the outer surface, there was no actual flow. A crack about 2 ft. long developed in specimen *B*, extending from one end to a knot, at a pressure of 90 lb. per sq. in. and active flow continued until the load was reduced to 50 lb. per sq. in. This latter specimen cannot be considered a good sample because of the defective pipe wall. Although the pipes were not tested to rupture of the steel bands, the investigation was considered successful, since it indicated quite clearly that the distribution systems from which the specimens were extracted may be retained for some time—provided undue leakage is not experienced at the joints and the pressure is maintained below 100 lb. per sq. in.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Hoover Dam Not Comparable to St. Francis Dam

To the Editor: The paper entitled "Safety Limitations of Hoover Dam," which appeared in the July number of Civil Engineering, creates the impression that the author had never visited either the St. Francis or the Hoover Dam sites and did not know that the first was a curved gravity type and that the second is to be an arch structure. The St. Francis Dam was a curved gravity structure on an entirely unsuitable foundation. Hoover Dam is to be essentially an arch dam with an excellent foundation and almost ideal abutments.

Neither abutment of the St. Francis Dam was suitable for either a gravity or an arch dam. The conglomerate of the right, or west, abutment, when dry appears reasonably sound, but it rapidly disintegrates in water. The planes of schistosity of the east abutment were parallel to the sides of the canyon and presented little resistance to sliding.

The foundation of the St. Francis Dam was such that water pressure would readily be transmitted through the conglomerate and would be applied to a very large percentage of the base. The leakage under the dam—mostly from the west side—increased from 70 gal. per min. on February 29, 1928, to 450 gal. per min. or more on the afternoon of March 12, 1928. The dam failed that night. In the bottom, where the dam rested on the edges of the schist planes, water pressure could readily have been transmitted to the base of the dam and applied directly to a large area.

The rock forming the canyon walls and bottom of Black Canyon is not permeable. It has ample strength, nearly twenty times the maximum stress in the concrete, and it stands nearly vertical.

No geologist passed on the St. Francis Dam site. Geologists of international reputation, after careful study of the locality, have passed favorably upon the Hoover Dam site. The work so far done on the diversion tunnels at Hoover Dam site confirms the opinion of these geologists as to the quality of the rock.

The drainage system at the St. Francis Dam, if it could be called such, consisted of 10 holes in the foundation. The holes were 3 in. in diameter and were spaced about 20 ft. apart, and the depth, as stated by various persons, was from 15 to 30 ft. A piece of $2^1/_2$-in. pipe was grouted into the top of each hole and these pipes were all connected to one drain pipe. The area drained was a very small part of the bottom. No grouting of the foundation was done. No contraction joints were provided. No attempt was made to drain the dam itself. In fact, practically nothing was done to reduce uplift.

On the other hand, every precaution is to be taken at Hoover Dam to prevent uplift. Its foundation and abutments will be thoroughly grouted and both the dam foundation and the abutments will be adequately drained. Hoover Dam is designed to be safe against any forces which have been conceived as possible by a most able staff of engineers, including men never previously connected with the Bureau of Reclamation.

In computing the sliding factor of the Hoover Dam, Mr. Gerry assumes it to be a simple gravity structure without arch action. Starting with this wrong premise, he then forgets the downward pressure of the water on the sloping portions of the upstream face of the dam and then assumes upward pressure to be applied on 100 per cent of the base—an impossibility. If his method of computing the sliding factor be applied to any arch dam, especially to thin arches, an absolutely incorrect result would of course be found.

So far as the writer is aware there is no existent concrete or masonry dam, in America at least, which was designed to resist earthquake shock. Three are projected which do include this force; these are the Hoover Dam, Pasadena's Pine Canyon Dam, and the Madden Dam on the Chagris River, Panama. If the same severe conditions, assumed in the designing of these dams, were applied to most masonry dams now in service, stresses would be found to exist far in excess of those which will develop in Hoover Dam.

Louis C. Hill, M. Am. Soc. C.E.
Consulting Engineer

Los Angeles, Calif.
August 10, 1931

Hoover Dam Criticism Not Convincing

To the Editor: I disagree entirely with the opinions expressed by W. H. Gerry, Jr., M. Am. Soc. C.E., in his article on "Safety Limitations of the Hoover Dam," as published in the July issue of Civil Engineering. He considers the dam as a whole and wrongly states that the sliding factor will be $\frac{3,400,000}{3,600,000} = 0.94$. The real sliding factor, with full uplift, will be 0.74, as is shown by the following data, which may be verified by those interested.

Items	Millions of Tons
Total weight of concrete in dam	6.747
Total weight of water on upstream face	0.706
Total weight of water on downstream face	0.020
	7.463
Total uplift on base of dam	3.108
Net vertical weight	4.355
Total horizontal downstream pressure	3.258
Total horizontal upstream pressure	0.033
Net horizontal downstream pressure	3.225

$$\text{Sliding factor} = \frac{3.225}{4.355} = 0.74$$

This result is for the assumption of uplift over the entire base. But it is impossible for the entire base of the Hoover Dam to rest on a continuous film of water or for continuous films of water to extend through the rock foundation. Full uplift cannot occur unless one, both, or a combination of these conditions exist. If uplift should act over two-thirds the area of the base, the sliding factor for the Hoover Dam, considered as a unit, would be 0.60. This is a conservative figure.

Further, Mr. Gerry states that "there has never been a rational solution of the problems of indeterminate support for arched gravity dams." I would extend this statement. There never has been a rational solution for the stresses in straight gravity dams in narrow canyons. Mr. Gerry, however, proposes one for the Hoover site. Foundation deformation, foundation re-

actions, variability of the elastic modulus, temperature effects, transverse arching, are among the important factors that are as yet beyond a rigid mathematical solution.

Straightening out the Hoover design and adding $5,000,000 worth of concrete to it, as proposed by Mr. Gerry, will not render it susceptible of a "rational analysis." It will, however, make it entirely dependent on frictional resistance. Referring to a gravity section, he correctly states: "it remains in place solely by reason of reactions resulting from friction at or near the foundations." In the next sentence he says: "The coefficient of friction is a factor of experiment and is uncertain to a degree." He objects to the present design because he considers that the methods used in its analysis are not rational enough. Instead, he proposes a section which not only is not susceptible of a rational analysis but depends entirely on frictional resistance, which he himself states is "uncertain to a degree."

Also, Mr. Gerry goes far afield when he links together the St. Francis and Hoover designs and dam sites. There is nothing whatever in common between them with the exception of the 500-ft. radius at the crests. In all other respects they are entirely different, as an unbiased comparison of data will show. He infers that the Bureau of Reclamation would have approved the St. Francis design "in accordance with the same school of thought and on altogether similar lines." From an extended service with the bureau and an acquaintance with its personnel, I can state without any hesitation that a concrete dam would not have been even considered for the St. Francis site. The comparison might better have been made between the Arrowrock, Gibson, and others of the high dams built by the bureau, not one of which has failed or shown signs of failure.

Not being especially enthusiastic over gravity dams, either straight or curved, but having some knowledge of the foundation conditions at the Hoover Dam and of the modern designing methods used by the bureau, I would require much more accurate and much more rational criticism than that presented by Mr. Gerry before questioning the safety of the dam.

C. H. Howell, M. Am. Soc. C.E.
Chief Engineer, J. G. White Engineering Corporation, S. en C.

City of Mexico, Mex.
August 24, 1931

Need for Columbia River Commission

To the Editor: I was greatly interested in Major's Butler's paper, which was published as part of the symposium on "The Columbia River—for Irrigation and Power," in the September issue of Civil Engineering. He is to be complimented on the thoroughness of his presentation of the basic facts and conditions upon which must be predicated the economic development of a great river system—particularly in view of the restraint he must have felt in dealing with the subject of an, as yet, unpublished official report.

It has been made clear that the Columbia and its tributaries constitute a great river system destined to play a large part in the drama of the development of the Northwest. In my judgment, the Columbia, next to the Mississippi, is the most important stream system in the United States. In power possibilities it greatly surpasses the Mississippi or any other river in North America, and in its irrigation possibilities and in the wealth of undeveloped natural resources within its drainage area, it must also be reckoned a great national asset.

It is a fine augury that the Federal Government has undertaken the preliminary study of this stream in a manner that indicates a desire not only to ascertain all its varied possibilities but also a desire to consider it as an interrelated whole. I do not wish to enter upon any discussion of the purely technical aspects of Columbia River development, but I should like to suggest a certain administrative phase of the situation which seems almost indispensable in the consummation of that development.

I refer to the need for creating a permanent national commission to deal continuously with the development problems and economic needs of the Columbia River system, as they arise, so that it shall be a coordinated, carefully scheduled, and timely development. An uncoordinated, piecemeal development would be an economic calamity. Just as it has been found necessary and beneficial to have a Mississippi River Commission and also a Colorado River Commission, although the latter is not yet set up in its most desirable form, so too will it become necessary and desirable, in my judgment, to create a Columbia River Commission for proper control of the development of that stream.

The states within the Columbia drainage area and the Federal Government should have membership on such a commission, which should have some well defined authority to deal with phases of the international problems attaching to an international stream. It is to be hoped that the Federal Government and the several states concerned will, in due time, formulate the legislation necessary for the creation of such a commission.

Joseph Jacobs, M. Am. Soc. C.E.
Consulting Engineer

Seattle, Wash.
September 15, 1931

The Capacity of Tunnels and Bridges

Dear Sir: I enjoyed reading Mr. Bryne's article on "Increasing the Vehicular Capacity of Manhattan's Bridges," in the July issue of Civil Engineering. The part dealing with the capacity of tunnels and bridges is especially interesting.

I have recently been making a comparison of the various highway tunnels of the world, and some of my conclusions are expected to appear shortly in one of the English technical periodicals. One of the points dealt with was the width of roadway in relation to speed and therefore to capacity. I assumed that the average length of vehicles was 25 ft. and that the clearance between them was equal to the distance traveled in two seconds. In this way I arrived at the following formulas:

$$S = 25 \text{ ft.} + 3\,M \text{ and } C = \frac{5{,}280\,M}{25 + 3M}$$

where S is the spacing from center to center, in feet, between vehicles; M the speed in miles per hour; and C the practical capacity in vehicles per hour. From this, I plotted the curve of capacity for one line of traffic and found that the speed increased rapidly up to 15 miles an hour, less rapidly from 15 to 25, and beyond that point at a much slower rate. I drew the conclusion that, as speeds up to 20 miles an hour can be obtained, with two traffic lines going in opposite directions, in a roadway about 20 ft. wide, there would be no economic advantage in widening the road further in such a costly structure as a tunnel.

Since arriving at these conclusions, I have found that neither my method nor my conclusions are new. In his

excellent book on *Highway Economics*, S. Johanneson has developed formulas which, transformed into my notation, become:

$$S = 25 \text{ ft.} + 2.2M \quad \text{and} \quad C = \frac{5{,}280M}{25 + 2.2M}$$

This gives capacities that bear a close resemblance to my own, though slightly higher all around.

I find, however, that Mr. Byrne has approached the subject from another point of view. He suggests a new way of arriving at the capacity, which fully bears out my conclusions. Expressing his ideas in the same notation, the equations would become:

$$S = 25 \text{ ft.} + 1.46\,M + 0.6M^2 \quad \text{and}$$

$$C = \frac{5{,}280M}{25 \text{ ft.} + 1.46M + 0.6M^2}$$

The capacity of a single traffic lane deduced from this shows a striking resemblance to Mr. Johanneson's figures up to nearly 15 miles an hour. After this it falls away rapidly and reaches a maximum at little over 20 miles an hour. Beyond this point it shows a gradually decreasing capacity, confirming my conclusions that high speeds do not tend to increase the capacity beyond 20 miles an hour if the same margin of safety is to be preserved. Higher speeds would no doubt influence the economic equations if an "attractiveness factor" were introduced, but that would be one on which it would be difficult to place a money value.

W. L. LOWE-BROWN, M. Am. Soc. C.E.
Consulting Engineer

Westminster, London
August 22, 1931

Modern Flood Control Measures Used by the Ancients

DEAR SIR: In his article, "Better Control of the Lower Mississippi," in the August issue of CIVIL ENGINEERING, Mr. Kemper offers the results of very interesting studies, which are worthy of serious and careful consideration in the final solution of the flood problem of the Mississippi River. While his "rate scale" for use in estimating flood flows below the confluence of large tributaries with the main stream, and the consideration of a combined flood relief and navigation channel may be new in connection with studies of the Mississippi, these ideas have previously been used in the analysis of floods and in works for river regulation and flood control.

One of the 308 reports being made by the U.S. Corps of Engineers has just been completed by the Sacramento District Office. The studies for this report included a very exhaustive analysis of flood flows for the period covered by the record. The computations assumed the Sacramento Flood Control Project as completed, and included the determination of probable rates of discharge, both with and without regulation by means of reservoirs for additional flood control.

The method of analysis was designed to take account of the effect of temporary storage in channels and bypasses for both rising and falling stages by means of curves and factors which appear to correspond with those used in the method developed by Mr. Kemper. In the Sacramento studies, corrections were also made for the additions to flow from unmetered drainage areas. Only one actual measurement of discharge at the mouth of the Sacramento is available for a check upon the computed discharge. This measurement, which was probably made shortly after the crest had passed, was a little more than 12 per cent less than the computed value. The actual error in this case was probably even less than was indicated since some flow was lost and delayed through a breach on one of the largest tributaries.

The experience in these 308 studies tends to establish the reliability and usefulness of Mr. Kemper's methods. A somewhat similar method was also used 8 or 10 years ago in an analysis of some of the major floods on the Yung Ting Ho in North China, where storage and seepage losses were an important consideration in the determination of flood flows in a river channel with levees which were old when Marco Polo visited China and described the bridge over this stream.

It may also be of interest to note that the Machang Canal near Tientsin, North China, was built by Li Hung Chang, then Viceroy of the Province of Chihli, as a combination navigation, irrigation, and flood relief channel. In its flood control capacity, it was to provide relief by diverting surplus flood waters from the Grand Canal south of Tientsin to a point near the mouth of the Hai Ho. It also provided a waterway for the transport of troops and supplies from a military post on the Grand Canal to another on the lower Hai Ho, as well as for commercial purposes. This project was undertaken as a flood relief measure, following the successive deterioration of older flood channels and spillways which had been rendered ineffective by the accumulations of silt resulting from centuries of use.

R. D. GOODRICH, M. Am. Soc. C.E.
Professor of Civil Engineering
University of Wyoming

Laramie, Wyo.
September 15, 1931

Wind Stresses in Reinforced Concrete Buildings

TO THE EDITOR: Please let me express my appreciation of the Progress Report of the Structural Division's Subcommittee, which I read in the March issue of CIVIL ENGINEERING. I feel sure that this report will go far to clear up some of the uncertainties surrounding the subject of wind bracing and will make for more economical and safer buildings.

In accordance with the recommendations of the Joint Committee, I commonly use the clear opening as the span in computing dead- and live-load moments and shears in reinforced concrete beams. The usual methods of analysis of frames subject to wind stresses use center-to-center dimensions in estimating moments and shears due to wind loads. The two are not consistent. There is no reason why wind loads are different from other loads. It appears to me that the subcommittee or some other committee can profitably devote some time and thought to assisting the profession to find more logical methods of computing wind stresses in reinforced concrete buildings.

I have been using center-to-center dimensions of columns and girders in my practice, not because I consider the procedure correct, but because it is easy of application and does not get the designer into any difficulties. It involves calculating moments at the faces of members rather than at intersections. In some respects, it seems more correct to base moment calculations on the clear spans of girders and the clear distances from the upper or the lower surfaces of a girder to the adjacent assumed point of counterflexure of the column—especially when clear openings are used for

live- and dead-load moments. However, column loads so determined do not balance the total external moment, unless the dimensions of the building are taken as the sum of the clear openings, an incorrect assumption.

May I suggest that many more engineers are interested in the proper design of buildings of moderate height than they are in the design of the super-towers of New York. We can now obtain factory-made concrete of any specified strength, and the practicable height of concrete buildings is greatly increased. Far too many concrete buildings have been designed and built without any proper consideration of wind stresses. Most designers do not have the time or mathematical foundation required to follow out the more exact and complicated methods of analysis, but do need help in providing safer buildings than have been built in the past. A reinforced concrete building is inherently stiff—much stiffer than a steel building in which horizontal bracing has been neglected or poorly done, but that is no reason for ignoring horizontal bracing.

If the members of the subcommittee could give to the profession some simple specifications, explaining how the usual methods of finding wind stresses can be applied to reinforced concrete buildings, it would render a real aid to many of us who are responsible for the safety of buildings ranging in height up to 30 stories. The subject of unit stresses might also receive consideration. What are to be the maximum allowable combined stresses in concrete and reinforcement?

Frank W. Chappell, M. Am. Soc. C.E.
Consulting Engineer

Dallas, Tex.
August 15, 1931

Searching for an Efficient Gravity Dam Section

Editor: The article by Dr. Grunsky on "Honeycomb Gravity-Type Concrete Dams," in the April issue of Civil Engineering, suggests several thoughts. As is known, the material in a gravity dam is not fully utilized—that is, the stresses are too low. This is especially true of the upper part of the structure. Of course, with concrete dams, some adaptation to this stress condition can be obtained by changing the mixture ratio, making it leaner toward the top. But there is a minimum amount of cement that cannot be reduced further because of such requirements as impermeability to water and frost resistance. If we assume the compressive strength with the minimum amount of cement to be 100 kg. per sq. cm. (100 tons per sq. ft.) and use a factor of safety of 5, the permissible loading will be 20 kg. per sq. cm. (20 tons per sq. ft.).

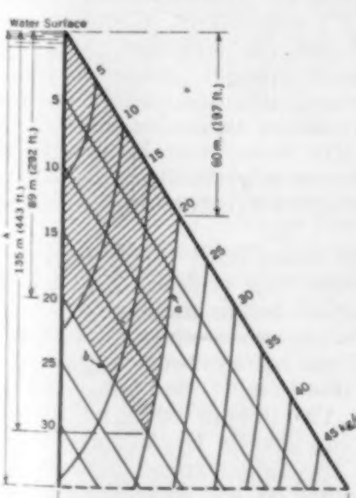


Fig. 1. Lines of Equal Stress in a Gravity Dam
Stress in Shaded Area Less than 20 Tons per Sq. Ft.

The theoretical profile of a gravity dam is shown in Fig. 1, on which are also indicated the isostatic lines—that is those of equal main normal stresses. The group of curves, *a*, represents a filled reservoir, and the group *b*, an empty reservoir. The section is shaded in places where the stresses are less than 20 kg. per sq. cm. (20 tons per sq. ft.). This part of the concrete cannot be stressed to the permissible limit. This fact was the first reason for proposing new dam types with better utilization of material, and consequent saving. The second reason for new types was the effort to obtain more uniform stress distribution and greater stability. If it is required that the normal stresses in all horizontal sections, with either empty or filled reservoir, be uniformly distributed, and that the pressure line run centrally, a symmetrical triangular profile is obtained in which the resultant water pressure passes through the center of the base of the section. It can be found by simple geometrical relations that the relative base width—that is, the ratio of width to height, has a value of $\sqrt{2}$.

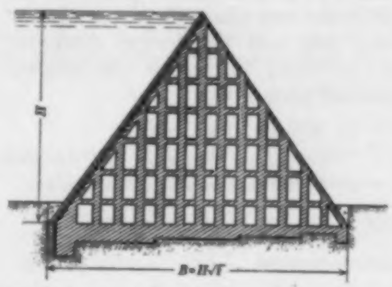


Fig. 2. Symmetrical Cellular Dam

Although the formula for the calculation of a normal gravity section contains the specific gravities of the masonry and the water, the symmetrical profile previously mentioned does not depend on any of these factors.

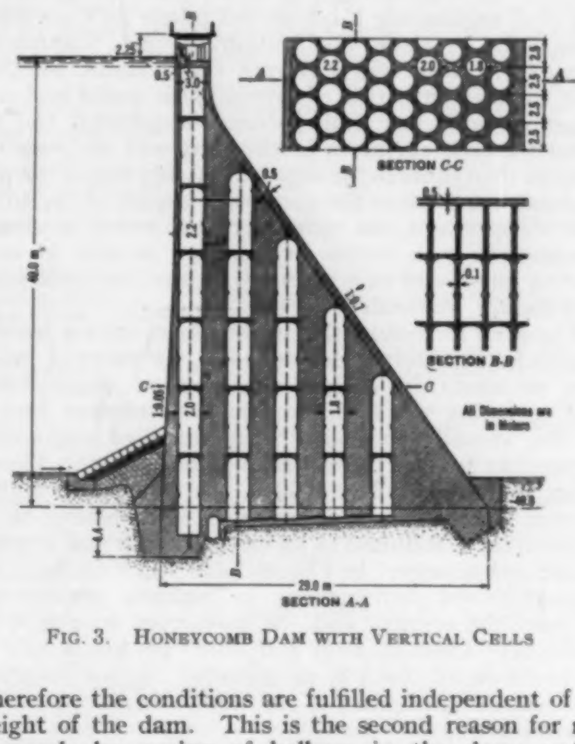


Fig. 3. Honeycomb Dam with Vertical Cells

Therefore the conditions are fulfilled independent of the weight of the dam. This is the second reason for new proposals by saving of hollows in the dam, and it reacts favorably on the section because the stresses are lower.

Of the many proposals that have been made, I shall mention only those that are almost identical with Dr.

computed discharge. This measurement, which was column—especially when clear openings are used for

Grunsky's proposal. The Austrian engineers, Pokorny and Rupli, of the firm of Redlich and Berger in Vienna, started with the second principle and reached the above-mentioned symmetrical profile. This design was patented in 1910. Another proposed type of cut-out section is indicated in Fig. 2. The Swiss engineer, Gutzwiler, started with the great resistance of the honeycomb cell, and in 1920 applied for a patent on a dam with vertical, circular, or hexagonal cut-out sections (Fig. 3). And finally, as has already been mentioned by L. R. East in the September issue of CIVIL ENGINEERING, De Gaetani proposed a model with horizontal tunnel-like cut-out sections, which were to be filled with broken stone.

These proposals have not been reduced to practice because of the high cost of forms and the difficulties of construction. The increased cost and the longer time required for construction probably outweigh the advantages of the above-mentioned proposals.

N. KELEN, DR. ING.
Consulting Engineer and Lecturer
Berlin Technische Hochschule

Berlin, Germany
September 10, 1931

Civil Engineering Field Not Overcrowded

EDITOR: The subject of overcrowding in the field of civil engineering is an interesting one. Nevertheless, I feel that Mr. Campbell, in his letter entitled "Supply of Civil Engineers in Excess of Demand," published in the September issue of CIVIL ENGINEERING, has struck a note which, while it may contain a certain essence of truth, seems a most unfortunate utterance at the present time, when conditions are so abnormal, not only in engineering but in all lines of endeavor.

If civil engineering is considered purely as a vocation, there may be some justification for Mr. Campbell's viewpoint. However, it is very questionable whether, after the present period of depression is ended and construction work has again become important, the demand for civil engineers in the rank and file may not be more than equal to the supply. At any rate, if the professional rather than the vocational aspect of the situation is considered, the conclusion that recent graduates should seek new fields—presumably outside of engineering lines—and thus virtually forsake their profession, is certainly unjustified.

The need for technically trained men, with a breadth of general intellectual development, for posts of executive authority in design, construction, maintenance, and operation will be more than ever evident because of the steadily increasing magnitude of engineering enterprises of every description—such as the Hoover Dam, the Golden Gate Bridge, the Conowingo Hydroelectric Plant, and the mammoth undertaking of the Pennsylvania Railroad in its electrification and terminal construction project in Philadelphia and vicinity. The unprecedented development in highway construction all over the country and the mushroom growth of tall buildings—1,000 ft. high and over—present a new set of problems of the first magnitude. In my judgment, the consulting engineer is just beginning his task rather than finishing it.

If the prospective student regards civil engineering merely as a "job," to be worked at day after day, week after week, year after year, then I will, in some measure, agree with Mr. Campbell. If, however, the student enters upon his technical career with the goal of higher professional achievement always before him, and if he possesses the necessary qualities—perseverance, originality, the enthusiasm which acts as an inspiration to those around him, the faculty of cooperating efficiently and amicably with associates both above and below him, readiness to accept responsibility, and ability to perform successfully the duties imposed upon him—then, in my opinion, he should be encouraged in his aspirations, and his chances for success in his chosen profession are better today than ever before.

In engineering, perhaps even more than in many other fields, it is the man himself—his own personal qualities as well as his intellectual attainments—that makes for success. Technical education alone will not suffice to place him in the front rank.

FRANCIS P. WITMER, M. AM. SOC. C.E.
Director of Civil Engineering
University of Pennsylvania

Philadelphia, Pa.
September 4, 1931

Definitions Needed for Soil Science

TO THE EDITOR: Due to the excellent research work of the U. S. Bureau of Public Roads and the tremendous amount of publicity resulting from Dr. Terzaghi's activities and studies of soils, we seem to have come into a new phase of experimentation with earth—that is, the organization of private soil-research laboratories. Their value in furthering general knowledge can only be measured by the results obtained after a long period of trial. The amount of real progress will depend largely upon the freedom with which information will be published and ideas and methods exchanged.

The study of earth from an engineering point of view has been a hobby of mine for some 12 years. The chief difficulty connected with this study has been a lack of agreement on the subject of definitions. It is as though each authority on the subject used his own original vocabulary. If the private laboratories can agree upon a vocabulary—that is, upon the definition of terms—a great step toward a soil science will have been made.

In a paper on "Lateral Earth Pressure," published in the 1923 TRANSACTIONS of the Society, I suggested that, for the purposes of engineering design, soils be classified according to their physical characteristics, defining a material by its elastic strain, plasticity, and fluidity. These strains can be measured, and such characteristics as moisture content, shape of grains, and variation in gradation, silt, and colloid content, will be revealed in their effects on one or more of the coefficients measured. The table given by Charles H. Lee, M. Am. Soc. C.E., on page 1020 of the August issue of CIVIL ENGINEERING, is an extension along similar lines.

Failure of soil always shows itself in the form of a strain, such as a settlement, slip, or flow. The limiting loads which can be carried before such failures occur can be determined by laboratory methods, if, and only if, a true sample of soil can be obtained. Considerable progress in obtaining true samples has resulted from methods developed by the Bureau of Agriculture in their farm soil studies and also by Dr. Terzaghi. Perhaps we shall soon see the disappearance of wash borings and their replacement by soil sample collections.

JACOB FELD, ASSOC. M. AM. SOC. C.E.
Consulting Engineer

New York, N.Y.
August 27, 1931

SOCIETY AFFAIRS

Official and Semi-Official

The Engineer's Salary and Budget

A Message for Times of Prosperity and Depression

Members of the Society:

A recent editorial paragraph applies as keenly to the engineering profession as to any group:

"One compensation for a period of bitter economic depression is to dissipate the mood of carelessness prevailing in prosperous times, and awaken earnest thought on the wise conduct of life."

It raises such personal questions as these:

"Has my past standard of living been extravagant?

"Have my expenditures been properly balanced among themselves?

"Have they been haphazard or pre-planned?"

A salary may be defined as a time-rate wage, paid periodically to a person for his work in a professional or sub-professional capacity. Such salary, together with other income, must at least balance the expense side of the ledger. An engineer has three kinds of expenses to meet: the living expenses of himself and his family; savings (or their equivalent in pension guarantees) to assure economic security; and strictly professional expenditures for such items as professional periodicals and books, society dues, expenses of attendance at professional meetings, professional tools, and plant.

A tentative list of annual budget items for engineers is as follows:

I. Professional needs
   1. Membership in four or five professional societies, costing from $10 to $25 up
   2. Attendance at one or two professional meetings, costing from $50 up
   3. Professional books, costing $30 and up
   4. Professional magazines, costing from $10 to $25 and up
   5. Travel for purposes of professional and cultural study, $100 or more

II. Economic security
   1. Retirement annuity, 5 per cent of income (perhaps with employer contributing 5 per cent more) and the annuity's reserve accumulation available in case of permanent disability or death before retirement
   2. Life insurance costing 6 or 7 per cent of salary, to give a minimum protection of about three times the amount of salary; increased by term insurance during dependency of children and until annuity reserve accumulates; or inincreased by group life insurance costing $1^1/_2$ per cent of salary and giving life insurance equal to one's salary, plus disability and sickness insurance.
   3. Sickness and disability income, provided:
      a) By group insurance as just mentioned; or
      b) By a disability clause in one's regular life insurance policy; or
      c) By a special sickness and disability insurance
   4. Provision against unusual emergency expenditures, provided by an additional reserve fund, either personal or pooled with others, about 5 per cent of salary

III. Living costs for engineer and family

These recommended expenditures are seen to amount to from 30 per cent of a $2,000 income down to 25 per cent of a $10,000 salary. To most engineers with families, these ratios will seem large. They are presented as possible ideals for use in such a detailed budget as every man should adopt and follow. One might ask why, or how, in times like these, such an ideal is to be obtained. This is just the time to start, perhaps on a budget containing only the items of food, lodging, clothing, and carfare. Later, after an income has been secured, there should be additional items, savings to provide for recurring emergencies and, still later, true savings and insurance. It is not necessary or possible to formulate a budget designed to be followed without reference to the amount of one's income. This is not possible even on a percentage basis, because the rent item can legitimately be made to fall off as income increases, whereas the item of incidentals can be more than correspondingly increased. Bankers, economists, and sociologists all advocate personal and family budgets.

Ten thousand budgets should be formulated by ten thousand engineers during this time of stress, and consistently followed through the intervening period of prosperity to the next economic depression. Could a history of the resulting experiences be written when that time comes, the best possible guide would be furnished for the then rising generation—to be ignored as in the past. At the same time, such budgets would be of inestimable benefit to those who formulated them and to their friends.

Respectfully submitted,

Ernest P. Goodrich, M. Am. Soc. C.E.

September 14, 1931 *Chairman, Committee on Salaries*

Lectures Available for Student Chapters

As the winter is approaching and the colleges are opening their sessions, it is not too soon to remind the Student Chapters of the lantern lectures available for their use. There are 13 different titles in the series, and two sets of slides have been made up for each, so that 26 groups could be served at one time, should the demand be so great.

A box of slides and a mimeographed lecture—which may be expanded or condensed to suit the audience—will be sent on request to any Student Chapter of the Society, and postage will be paid both ways. Reservations can be made in advance for any date in the school year, and it is recommended that this be done early, to insure obtaining the particular material desired.

It may be of interest to consider how these lectures were actually used during the school year 1930–1931. Of the 153 meetings at which they were given, six were of groups other than Student Chapters. These included two or three Local Sections, and one college in Alaska, where no Chapter has been established. A list of the lectures, with dates and places used, is appended.

Title of Lecture	Inclusive Dates of Use	Times Used	Farthest Away from Headquarters
Carquinez Strait Bridge	Nov.–May	12	University of Arizona
Cascade Tunnel	Oct.–April	11	University of Idaho
Catskill Water Supply of the City of New York	Nov.–May	16	University of North Dakota
Conowingo Hydro-Electric Development	Dec.–April	5	Alaska Agricultural College and School of Mines
Coolidge Dam	Nov.–May	15	University of Utah; Montana State College
Florianopolis Bridge	Nov.–April	13	Oregon State College
Hetch-Hetchy Water Supply and Power Plant	Oct.–May	9	Oregon State College
Holland Tunnel	Oct.–May	17	Oregon State College
Flood Control in the Miami Conservancy District	Nov.–April	12	Oregon State College
Mississippi River Flood Control	Oct.–May	15	University of Idaho
Muscle Shoals Hydro-Electric Development	Nov.–May	12	University of Idaho
Recent Power Development at Niagara Falls	Dec.–May	8	University of Idaho
Westchester County Park System	Jan.–May	8	Montana State College
	Total	153	

Fall Meeting in Full Swing

Soon after this issue reaches its readers the Fall Meeting at St. Paul will be in full swing. The indications, at this writing, are for a large and representative attendance at the Society's four-day session, which will begin October 7. Those who find actual attendance, with its opportunities for comradeship, impossible will have their demand for the last word in professional

advancement satisfied in a subsequent issue of CIVIL ENGINEERING. That issue will contain abstracts carefully prepared from the papers presented at the meeting and from the official stenographic transcripts. Freely illustrated by diagrams and pictorial matter, these abstracts will present the important aspects of the meeting to those who could not attend and, for those who were present, will constitute a record of the meeting.

No one who has not served on a regional meeting committee can realize the great amount of thoughtful preparation that is required to arrange for the thousand and one details of program, publicity, entertainment, transportation, housing, and other arrangements for the comfort and convenience of those who attend.

It is impressive to see these meetings in every section of the country successfully arranged by local committees without previous experience. Does it not indicate that, "Where there is a will there is a way," and that when a group of engineers have a job to do, they do it creditably?

Society Publications in Review

Few, even of those who closely studied PROCEEDINGS as it appeared previous to the advent of CIVIL ENGINEERING, in October a year ago, probably realized the mass of information it presented or, for that matter, still does present. The ten issues of PROCEEDINGS, from October 1929 to September 1930, contained 1,830,000 words. CIVIL ENGINEERING has permitted the total output of the Society to be increased in the succeeding twelve months, October 1930 to September 1931, to 2,200,000 words or approximately 20 per cent.

With the exception of the volume of material incident to the publishing of the professional records of applicants for admission and transfer, all departments of PROCEEDINGS have been increased. These professional records fell off 50,000 words, or 14 per cent.

Items concerning Society affairs, since their transfer from PROCEEDINGS to CIVIL ENGINEERING, have been treated at an increase of 27 per cent in volume. The abstracts of the meeting papers, even with the omission of discussions, were enlarged 21 per cent, although part of this increase resulted from reporting five meetings instead of four. This plan of making the gist of Society meetings available at the earliest possible date following the meetings has justified itself in popularity and profit to members.

Memoirs increased about 30 per cent in volume. Papers and discussions other than meeting abstracts underwent an expansion of 29 per cent. This expansion should be viewed as an increase in the number of papers, both in PROCEEDINGS and CIVIL ENGINEERING, rather than as an enlargement of the papers themselves. The average number of words in individual papers, instead of being increased, has been decreased.

In the new set-up, PROCEEDINGS retains its character as a medium for the thorough presentation of technical treatises, including their discussions. Some papers, however, which under the former policy would have found their way into PROCEEDINGS, have been diverted to CIVIL ENGINEERING, and as a result have had to be condensed. In reality, the percentage of increase in the total number of words in technical papers therefore indicates a very considerable increase in the number of topics presented.

The accompanying diagram, Fig. 1, is an attempt to show graphically the manner and the degree in which the various parts of the former PROCEEDINGS, with its dense format, have been distributed between the two publications. The result is an improved presentation of subject matter, a 20 per cent increase in volume, and an even greater increase in the number of topics treated. This growth is strikingly illustrated in Fig. 2.

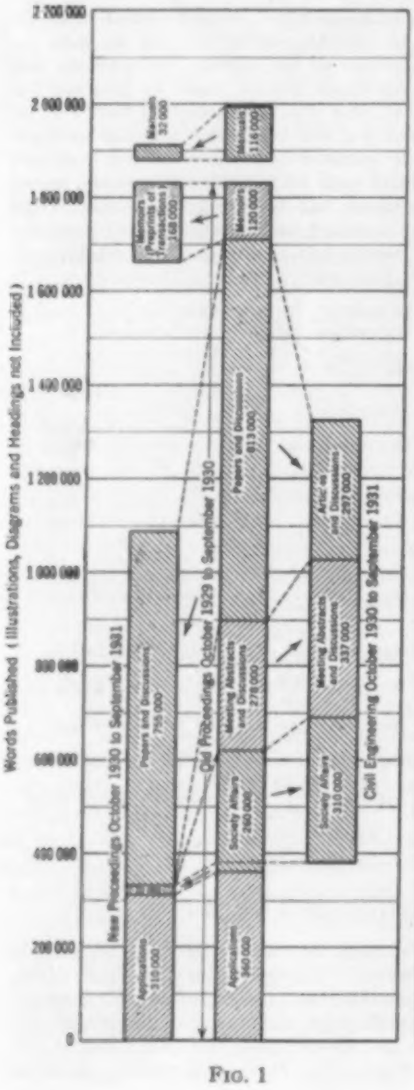


FIG. 1

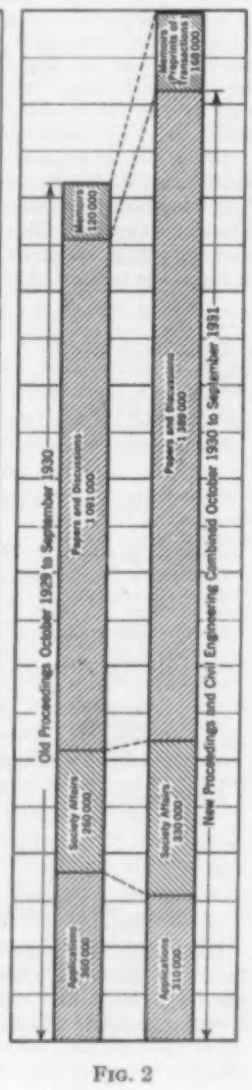


FIG. 2

Construction Division Announces Committee on Substructure Engineering

Appointed for the purpose of outlining safe, sane, and reliable construction methods for the substructures of buildings, bridges, subways, dams, and miscellaneous structures, the personnel of the Committee on Substructure Engineering has been named by Chairman J. P. H. Perry, M. Am. Soc. C. E., of the Construction Division. The committee expects to consider the characteristics of soils, excavation methods, and protection of adjacent buildings, structures, and property. All types of foundations are to be covered and consideration will be given to the most economical and safe procedure for each type, to establish, if possible, standards of clearance or tolerance for each construction method.

Chairmanship of the committee has been accepted by Alonzo J. Hammond, M. Am. Soc. C.E., of Chicago, and a list of the other members follows:

Dean G. Edwards	M. Am. Soc. C.E.	New York
A. C. Everham	M. Am. Soc. C.E.	Kansas City, Mo.
John C. Gotwals	Assoc. M. Am. Soc. C.E.	Washington, D.C.
Charles R. Gow	M. Am. Soc. C.E.	Cambridge, Mass.
Frederick H. McDonald	M. Am. Soc. C.E.	Atlanta
M. M. O'Shaughnessy	M. Am. Soc. C.E.	San Francisco
C. S. Proctor	M. Am. Soc. C.E.	New York
L. E. Ritter	M. Am. Soc. C.E.	Chicago
John R. Slattery	M. Am. Soc. C.E.	New York
John W. Taussig	Assoc. M. Am. Soc. C.E.	New York
Lionel R. Viterbo	M. Am. Soc. C.E.	St. Louis
Frank E. Weymouth	M. Am. Soc. C.E.	Los Angeles
Lazarus White	M. Am. Soc. C.E.	New York
Charles A.D. Young	M. Am. Soc. C.E.	Denver

Appointments of Society Representatives

SIR ERNEST W. MOIR, M. Am. Soc. C.E., has been appointed to represent the Society at the Faraday Centenary in London.

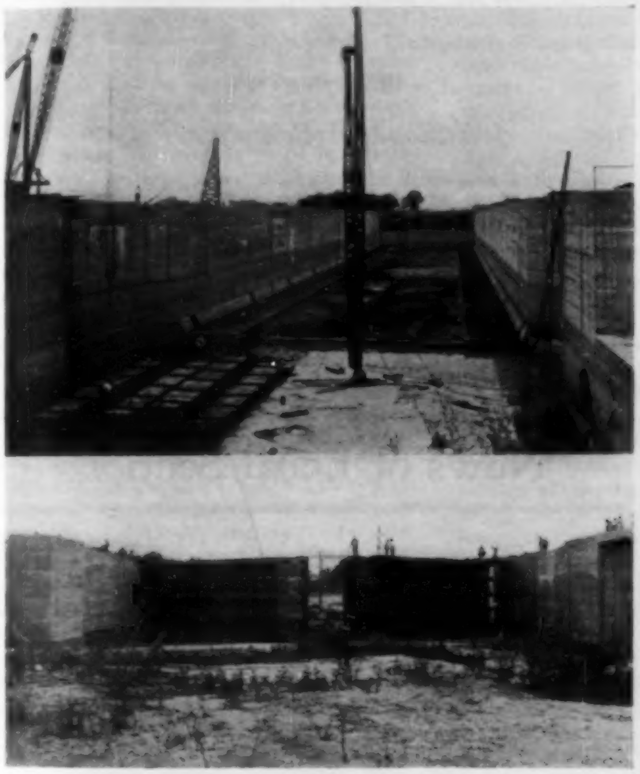
JOSEPH M. HOWE, Vice-President Am. Soc. C.E., will be the Society's delegate to the Seventh American Scientific Congress to be held in Mexico City, Mex., from February 5 to 19, 1932.

A Preview of Proceedings

The emphasis of the three new papers in the October issue of PROCEEDINGS is decidedly toward the practical. They are mostly concerned with problems of construction—on waterways and irrigation structures—and with the more general problems of foundation engineering. Members will find much of interest for study and for discussion.

ENGINEERING FEATURES OF THE ILLINOIS WATERWAY

A paper by Walter M. Smith, M. Am. Soc. C.E., Assistant Chief Engineer of the Division of Waterways of the State of Illinois, will deal with the Illinois Waterway, which extends from the south end of the Chicago Drainage Canal to the present head of navigation on the Illinois River at Starved Rock, near Utica, Ill., a distance of 60 miles. At only one or two points is the canal separate from the Illinois River or the Des Plaines River. In these sections, the waterway consists of an independent canal, but elsewhere the dredged river itself is utilized.



MARSEILLES LOCK, ILLINOIS WATERWAY
Upper Guard Gates on Upstream Side, Above;
Lower Gates, Below

First contracts for the improvement of this waterway by the State of Illinois were let in 1920. This project includes the construction of a lock at Lockport and of locks and power houses at Brandon Road, Dresden Island (near Marseilles), and at Starved Rock. The locks have usable dimensions of 600 by 110 ft. and lifts varying from 15 to 40 ft. Although the construction has not been wholly completed, the entire canal will be finished very shortly. The responsibility for the work has now been transferred to the Federal Government.

In his paper, Mr. Smith gives a summary of the engineering experiences encountered on the work and in doing so maintains a nice balance between the theoretical and the practical. While a large part of his article is descriptive of actual experience on structures built to date, it also includes a theoretical analysis presented in detail for the student and the designer. Examples for the design of culvert-valve chambers are given. The method is based on the principles of the Venturi meter as developed by the late Clemens Herschel, Hon. M. Am. Soc. C.E. The culverts in the side walls of the locks are circular. Therefore the stress could not be found by the method used when the culverts are rectangular. Under these circumstances, Mr. Smith pointed out that the most accurate method of determining the stresses in the masonry around the culverts is by applying the "principle of least work"—that is, the walls are analyzed under the assumption that the arch will do the least amount of work necessary to support the load upon it.

Proceeding on this basis, the author has developed the necessary formulas and has illustrated their application in a semi-graphical method by the use of funicular force polygons. A table is submitted which shows the complete steps in the determination of stresses in the wall of the Marseilles Lock.

A part of the paper that will appeal to many engineers is that containing a discussion of the comparative merits of various kinds of movable gates. An adaptation of the Taintor gate design was chosen for use on the Illinois waterway improvement. Commenting on this choice, Mr. Smith stated that the relative cost of the Stoney type and the Taintor gate type was about the same, but that the Stoney type presented several disadvantages as applied to the problems on this waterway. Using this type would have necessitated the installation of powerful machinery for placing the gates and for removing them when necessary. In short, a choice between these two types was decided entirely on the basis of the great difficulty of installing and operating the Stoney type of weir gates, hence, the selection of the Taintor gate, with the modifications necessary to adapt it to local conditions as analyzed by the engineers.

CONSTRUCTION WORK ON THE YAKIMA IRRIGATION PROJECT

In giving a comprehensive and clear picture of construction experience on the Yakima Irrigation Development, particularly on the Kittitas Division of that development, Morris Mason, Jun. Am. Soc. C.E., makes available for the profession a general descrip-

HORSESHOE CANYON SIPHON, YAKIMA IRRIGATION PROJECT
Placing Steel Plates, Handling Reinforcing, and Chuting Concrete

tion that might apply in typical detail to all Federal reclamation projects.

According to the author, surveys were begun in 1924 and the general authority for the construction work was contained in a contract dated December 19, 1925, between the United States and the Kittitas Reclamation District. Active construction work began in April 1926. There are about 96,000 acres included within the limits of the Kittitas Division. Of this area about 75 per cent is considered irrigable. Two impounding reservoirs are in use in connection with the lower Yakima Project, surrounding Yakima, Wash. These are situated at Lakes Keechelus and Kachess. Water from these reservoirs supplements the natural flow of the Yakima River, and it is diverted into the main canal of the Kittitas District at the foot of the Cascade Mountains by means of a dam north of the town of Easton, Wash.

The Diversion Dam has an over-all length of about 250 ft. and raises the water surface approximately 43 ft. above the low-water level of the river. The spillway capacity, with gates lowered, is about 13,000 sec-ft. whereas the maximum recorded flow of the river at this point is 6,000 sec-ft.

In tabular form, Mr. Mason presents the dimensions and hydraulic properties of 22 different siphons, and another table gives the dimensions and hydraulic properties of 11 tunnels built on the main canal and on the north and south branches. Considerable space in the paper is given to the construction and design of the wasteways. The author describes fully the methods used to insure a uniform quality of concrete. In this connection, three examples of inspector's daily reports should prove of interest and of value to engineers in the field.

Soil Mechanics Research

Another paper to appear in the October issue of PROCEEDINGS should prove of great value to the construction man in his study of the individual problems which come up in connection with every construction job. The practical analysis of soils as a foundation medium received its greatest impetus through the recent efforts of Dr. Charles Terzaghi, who made far-reaching studies in this field.

The present paper, "Soil Mechanics Research," by Glennon Gilboy, Jun. Am. Soc. C.E., Assistant Professor at Massachusetts Institute of Technology, contains a description of laboratory methods of analyzing soil specimens as developed in the institute's laboratory. Research in soil mechanics was begun there in the autumn of 1925 by Dr. Terzaghi, when a graduate course in soil mechanics was founded, the undergraduate course in foundations revised, and experimental work begun.

Investigations described in the paper by Professor Gilboy arose primarily through problems encountered in actual engineering work. Questions which came up in Dr. Terzaghi's consulting practice proved to be an inexhaustible source of stimulation and led to an increase of knowledge that could scarcely have been obtained otherwise.

Under cooperative agreements, the institute has investigated and tested soil characteristics for highway foundations, for hydraulic fill dams, puddle core walls for earth pressures against retaining walls, and numerous other useful purposes.

The experiments performed on the borrow-pit material for a proposed hydraulic fill dam in Pennsylvania furnished the data for preparing a suitable program for the investigation of the core of the Germantown dam. Soil studies for two large earth dams in Massachusetts called attention to the shortcomings of the method for computing permeability from the results of mechanical analysis, and provided an incentive to develop rapid methods for direct permeability tests.

An extensive groundwater survey, in the flats along the Connecticut River, supplied for the first time conclusive information as to the air content of alluvial deposits. Test borings in Arkansas and drainage investigations in Spanish Honduras furnished data as to the permeability of stiff clay soils with crumbling structures. Some of the contracting parties themselves established laboratories equipped with duplicates of the apparatus used at the institute's laboratory.

Practicing engineers who are concerned with earth pressures, and particularly with soil analyses as related to foundation work, should find this paper literally a manual of information on this subject.

More Requests for First Issue of Civil Engineering

The October 1930 issue of CIVIL ENGINEERING is entirely exhausted, and Society Headquarters has on hand a list of 29 members and institutions who desire to obtain this initial number for the sake of completing their permanent files. Likewise, the November issue is practically out of print. Consequently, any member or subscriber who does not wish to retain either of these issues for his complete record, would confer a great favor upon those who have asked for these numbers by forwarding them to the Headquarters of the Society.

A request has already come in from a forehanded member for an index to Vol. I, so that it may be bound with the first 12 issues. He received the reply—and others may wish to know—that there will be 15 issues in Vol. I. As will be noted, the present issue of CIVIL ENGINEERING is No. 13. With the publication, in December, of No. 15, a complete index to Vol. I, ready for binding, will be mailed to each member. Thus No. 13 appears for the first, and perhaps for the last time on the cover of an issue of CIVIL ENGINEERING. For the convenience of the Headquarters staff, a number of books containing the first nine issues have been bound. This size is not too heavy to handle with ease. However, the 15 issues of Vol. I may be more readily handled if they are bound in two books of nearly equal size.

A National Reclamation Policy

A limited number of reprints from TRANSACTIONS on the subject of "A National Reclamation Policy" are available for distribution. This is the report of the committee of the Irrigation Division on that subject, with two explanatory statements by J. B. Lippincott and Elwood Mead, Members Am. Soc. C.E. The many discussions that have appeared in PROCEEDINGS at various times have been collected and are bound together with the report. A charge of $1.20 each (60 cents to members) is made, and orders will be filled as long as the present supply lasts.

News of Local Sections

Colorado Section

The annual picnic of the Colorado Section was held on the top of Flagstaff Mountain, at Boulder, on June 13. After a dinner, served at the lodge, under the direction of Professor Hutchinson, officers elected for the coming year were announced as follows: C. L. Eckel, President; L. F. Copeland, Vice-President; and R. J. Tipton, Secretary-Treasurer. After the business session, the balance of the evening was spent in inspecting the new Memorial Building on the Campus of the University of Colorado and in social diversion. There were 63 members and guests in attendance.

Georgia Section

On August 3, the Georgia Section held its regular meeting at the Atlanta Athletic Club. Due to illness, James A. Perry, who was scheduled to speak on "The Engineer as an Expert Witness," was unable to attend the meeting, so J. Houstoun Johnston delivered his comments on the subject.

A report for the Functional Expansion Program Committee on suggested procedure in promotion of the Engineering Registration bill was given by C. C. Whitaker. After that, Henry M. Payne, of Washington, D.C., representing the American Mining Congress, spoke extemporaneously on the topic, "Balance in Industry." Among the guests at the meeting were members of the A.S.M.E. and A.I.E.E.

Miami Section

At a recent meeting of the Board of Directors of the Miami Section, the resignation of Edmund Friedman, Secretary, was accepted. This resignation was necessitated by the fact that Mr. Friedman is moving to another city. The directors have appointed L. G. Schreffler Acting Secretary.

ITEMS OF INTEREST

Engineering Events in Brief

November Civil Engineering

Present indications are that the November issue of Civil Engineering, Vol. 1, No. 14, will contain articles gathered from the four quarters of the globe and covering various fields of interest—dealing with a sewage disposal plant which has been started in New York; a reinforced concrete factory building erected during freezing weather by native labor in Korea; and, in southern California, the construction of marine terminal facilities from reinforced concrete impregnated with asphalt. In addition, an interesting description of the water supply problems of Constantinople (Istanbul) has come from an American engineer resident there. Other articles—on engineering education, on bridges, on highway construction, and on the explanation of the peculiar behavior of reinforcing bars during bending—are available for selection from those now being prepared for publication.

When Manhattan Island was all of the City of New York and was surrounded by bodies of pure water, the disposal of sewage and other municipal wastes by dilution in these waters was a logical treatment. The continuous discharge of wastes from the rapidly growing industrial and residential developments which now crowd both shores of the waters surrounding the island, has so polluted these waters that they will no longer sustain animal life. The harbor waters are so poisoned that chemical treatment of wooden pier construction as protection against teredo and limnoria is not now necessary, and safe bathing beaches are only to be found at a considerable distance from the nation's largest city.

As a first step to correct this condition, construction has begun on Ward's Island in the East River of the first of 30 centrally located treatment plants, to handle the billion and quarter gallons of sewage which are now discharged into the harbor every 24 hours. Details of this $30,000,000 activated sludge plant will be described by George W. Fuller, M. Am. Soc. C.E. The proposed method of sludge disposal is by hauling it out to sea in special 1,500-ton vessels.

An enterprising American firm has completed a modern factory building for the Nippon Corn Products K.K., at Heijo, Korea, which manufactures starch, corn sugar and syrup, edible oils, and cattle food. It is the second largest plant of its kind outside the United States. The same company operates one larger factory in Germany. The Korean structure has a steel frame and is founded on spread and mat footings resting on gravel. It is designed to resist earthquake stresses equal to 0.1 G. To resist the action of moisture and acids incident to the manufacturing processes, the steel in the reinforced concrete floors and walls is imbedded in the concrete more than the usual depth. Native laborers, totaling 1,800 men during the height of the building activity, were successfully employed. Work was continued without interruption during the severe winter weather of 1930–1931. This article has been prepared by W. N. Thompson, Assoc. M. Am. Soc. C.E., Manager of the Japan Branch of the H. K. Ferguson Company.

For a number of years Waldo E. Smith, Jun. Am. Soc. C.E., has been a resident of Constantinople, where he has taught civil engineering at Robert College. He has made an interesting study of the city's ancient water supply system from its initial development by the Emperor Hadrian in 117 A.D. down to the present day. Now the works, after a continuous process of reconstruction and enlargement, consist of three masonry dams forming storage reservoirs, a masonry diverson dam, and a number of developed springs. This article by Professor Smith may be considered as an authoritative statement of the engineering features of an ancient and yet modern municipal water supply system, with its pressure conduits, gravity aqueducts, tunnels, pipe lines, and purification works.

Although the problem of deterioration of cement concrete in sea water has not been solved, a great deal has been learned by experience in harbor construction. The causes of deterioration are generally attributed to chemical decomposition inducing mechanical disintegration, and to physical destruction due to the force of heavy surf or swell, especially within the limits of the tidal range. Experience at Los Angeles harbor relating to these problems and to the asphalt impregnation treatment for concrete exposed to sea water, will be discussed by George F. Nicholson, Harbor Engineer for Los Angeles. His article will be found to be a valuable contribution to the literature on the subject.

Edwin H. McHenry Wills Substantial Estate for Research

By the will of the late Edwin H. McHenry, M. Am. Soc. C.E., who died August 21, 1931, the United Engineering Trustees, Inc., has been made residuary legatee of an estate said to amount to $225,000. This fund for research is given by Mr. McHenry as a memorial to his wife, Blanche H. McHenry, who died some years ago. Two smaller bequests to individuals are included in the will, but one, of $10,000, may also revert to the United Engineering Trustees.

It is evident that Mr. McHenry had long been interested in the work of Engineering Foundation. In 1922 he stated that he had made a small provision for it in his will. In March of this year a codicil was added giving the new name, United Engineering Trustees, Inc. At one time he was receiver for the Northern Pacific Railway Company, and during the electrification of the New York, New Haven, and Hartford Railroad between New York and New Haven he was vice-president of that line. More lately he was in consulting practice.

COMING EVENTS

Fall Meeting of the American Society of Civil Engineers
St. Paul, Minn.
October 7, 8, 9, 10, 1931

American Society of Municipal Engineers
Pittsburgh, October 19–26

American Water Works Association
Central States Section, Annual Convention, Cincinnati, October 8, 9
Minnesota Section, Annual Meeting, St. Paul, October 30
Missouri Valley Section, Annual Meeting, Lawrence, Kans., October 29–31
Rocky Mountain Section, Annual Meeting, Denver, October 21–23
Wisconsin Section, Annual Convention, Racine, Wis., October 26, 27

California Sewage Works Association
Annual Convention, Monterey, Calif., October 12, 13

International City Managers' Ass'n.
Annual Convention, Louisville, Oct. 7–10

Missouri Water and Sewerage Conference
Jefferson City, Mo., October 22, 23

National Council of State Boards of Examining Engineers
12th Annual Convention, Detroit, October 1–3

National Safety Council
20th Annual Safety Congress and Exposition, Chicago, October 12–16

New York State Sewage Works Ass'n.
Fall Meeting, Ithaca, October 20, 21

Ohio Conference on Sewage Treatment
Annual Convention, Akron, Oct. 13, 14

Ohio State Planning Conference
Columbus, October 29, 30

Pittsburgh Chapter American Society for Steel Treating
Series of 15 Lectures on "Basic Principles of Metallurgy," Tuesday Evenings, September 8–December 15

Southwest Water Works Association
New Orleans, October 19–22

History of Human Endeavor Portrayed in Bronze

THE FIVE-TON doors at the entrance to the Imperial Chemical Industries Building in Millbank, London, are said to be the most remarkable in the world. Motors, which are fitted with an electromagnetic control, open the doors by the pressure of a button. The history of human endeavor in industry, cast in bronze, is depicted in the twelve panels. Six panels, two of which are reproduced here, illustrate the progress made by man from primitive times to the present era, by the application of science to industry.

One of these panels portrays early man as a builder and toolmaker. Instruments of flint and wood are being used to construct a monument—Stonehenge—in the distance. Other groups are building houses, and a gorge is being spanned by a twisted fiber rope bridge. Another panel illustrates the primitive practice of recording the longest and shortest days by a shadow mark, an ancient method of lifting water for irrigation, and the ceremony of the summer solstice.



UNIQUE BRONZE DOORS DEPICT THE HISTORY OF INDUSTRY
Imperial Chemical Building in London

Engineers Solicited for Restoration of Washington's Boyhood Home

MEMBERS of the Society have recently been approached to assist financially in the work of the Citizens' Guild of Washington's Boyhood Home, on the ground that Washington was an engineer and that therefore our members should be interested. Each contributor is to be presented with three etchings—one of the Hugh Mercer Shop, another of the Mary Washington House, and the third of the Mary Washington Monument.

The project, which is being carried out under the auspices of the Citizens' Guild of Washington's Boyhood Home, at Fredericksburg, Va., has a laudable objective, so far as can be ascertained, and one in which engineers may well take part, although they should understand the degree to which that participation is properly predicated upon loyalty to Washington, the engineer.

The Citizens' Guild of Washington's Boyhood Home was incorporated in the State of Virginia on January 2, 1926. It has acquired several properties: the Hugh Mercer Apothecary Shop, the traditional site of the Hobby School in Falmouth, the Gunnery Spring, the Powder Magazine Lot, and the Lucy Dixon Mill property. Also, it is understood to be seeking the acquisition of other sites of historic significance.

Of the Hugh Mercer Apothecary Shop, the *Free Lance-Star*, of Fredericksburg, on January 12, 1929, says it is, "more famous as the place where George Washington kept his desk for a number of years to transact the private business of his plantations on his frequent visits to Fredericksburg." It is understood that the shop has been repaired and is now a credit to the community. It is used in part as a museum, and in part as an office for the guild.

Concerning the traditional site of the Hobby School, the same account in the *Free Lance-Star* says: "Such schooling as he [Washington] received was in and near Fredericksburg. After learning all he could at Master Hobby's 'old field school' near the farm . . . in his twelfth year 'he made a daily journey on horse to what was considered a better school among the hills, ten miles away.'"

The Gunnery Spring property was a place where guns for use in the Revolutionary War were made and, during the progress of the war, were repaired. The Powder Magazine Lot and the Lucy Dixon Mill property, adjacent to the Gunnery Spring property, were also utilized during the Revolutionary War in connection with the manufacture of guns and powder and the storage of supplies.

National Safety Council to Hold Congress and Exposition

CHICAGO is to be the scene of the Twentieth Annual Safety Congress and Exposition of the National Safety Council, to be held October 12–16. In an official announcement, the Executive Committee gives the following statement of its policy and purpose:

"The National Safety Council's objective is the elimination of accidents to men, women, and children, as being deplorable, unnecessary, and wasteful. It seeks memberships, cooperation, and contacts to insure that its services may provide the instrumentalities and finances to accomplish this objective.

"Through education it seeks to demonstrate that the safe way is the right way and the best way, from the standpoint not only of human satisfaction but of social efficiency and economy. It seeks those ways and means for safety that satisfactorily fit into the practical affairs of life.

"Its financial policy is to return in service all moneys received, so operating without profit, and to undertake only those activities which can be assured of reasonable permanence. Much of its administrative personnel consists of volunteer workers.

"The National Safety Council holds itself open to give fullest and most cordial cooperation to all individuals, industries, organizations, communities, states, and nations that are in accord with the principles and objectives of the organization, and the National Safety Council likewise asks and seeks cooperation from all these in carrying out its purposes."

For the four-day session, a very comprehensive program has been arranged. Members of the Society will be interested in the meetings of the Cement Section, the Quarry Section, the Street and Highway Traffic Section, the Construction Section, and the sections on electrical railways, steam railways, public utilities.

and fire prevention; in the session on community safety; and in the sessions of the American Society of Safety Engineers and of the Traffic School. All meetings are to take place in the Stevens Hotel, and the exhibits will be in the Stevens Exhibit Hall. The headquarters of the National Safety Council are at 20 North Wacker Drive, Chicago.

Bridge Clearance Hearings Continue

VARIOUS district engineers of the Corps of Engineers of the Army have continued, during the summer months, to hold hearings on the possibility of establishing minimum horizontal and vertical bridge clearances over the principal streams of the United States. Since June 1, hearings have been held in the following states: California, Connecticut, Florida, Georgia, Indiana, Michigan, New York, North Carolina, Ohio, Oregon, South Carolina, and Virginia.

Those interested in navigation have attended these sessions most consistently, and representatives of many engineering societies as well as individual engineers have also been present. The Corps of Engineers has invited the participation of all interested parties, and from those who have found it impossible to attend, written statements have been solicited.

At the request of the Board of Direction, a committee of the Engineering and Economics Division, headed by Past-President J. F. Coleman, has been conducting a study "to formulate, if possible, the economic principles which should control with respect to bridge clearances, both horizontal and vertical; a definition of 'navigable streams'; and rational flood heights on which clearances should be based." A preliminary statement is to be presented and discussed at the Fall Meeting in St. Paul on October 9, and it is hoped to publish the findings in a subsequent issue.

Who's Who in Engineering Now Ready for Distribution

THE THIRD edition of *Who's Who in Engineering*, which contains biographical records of 12,000 prominent engineers, is ready for distribution. This is the first revision of this valuable work since 1925. The publisher has exercised great care in the selection of the biographies included, having based these selections on the general specifications of the Advisory Committee of American Engineering Council. Since *Who's Who in Engineering* is the only biographical guide to members of the profession, the announcement of this new edition is of great importance. Another interesting feature in connection with this volume, which measures 6 by 9 in., with 1,600 pages, is that it contains a complete geographical index.

Specifications for inclusion in the volume were: (1) outstanding and acknowledged eminence in the profession; (2) at least 10 years active experience, of which 5 years must have been spent in responsible charge of important engineering work; or (3) 10 years experience teaching engineering subjects in colleges or schools of accepted standards, of which 5 years must have been spent in responsible charge of a major engineering course. Subsequently it was found necessary to make minor extensions to these general requirements in order to accommodate small groups of engineers pursuing specialized work.

The publishers of this new edition of *Who's Who in Engineering* state that they have made a thorough and conscientious effort to secure biographical material from all engineers eligible for inclusion. In the preface of the new edition they remark as follows:

"It seems most unlikely that any engineer who has contact with his fellows of the profession could have failed to receive an invitation to submit data for this work, unless the conditions of his occupation have prevented him from receiving mail. Questionnaires were mailed to every available list of engineers, and practically every list was made available because of the essential nature and high standing of the publication. Every engineer represented in the previous edition was given an opportunity to revise his data so that his present record might be considered in the light of the new requirements for inclusion.

"Thousands of engineers suggested the names of friends in the profession; deans of schools of engineering submitted lists of notable alumni; engineering and industrial organizations offered the records of many of their staff, and thus, in the sense that the engineering profession is a full partner in every step taken in the compilation of this edition, it approaches the stature of an official publication.

"Admission to its pages is solely on the basis outlined above, and there is not a line of paid material in the volume."

The publishers feel that there are many engineers who underestimated the value of their work and for this reason failed to return the data requested of them. Of course, they were thus automatically excluded, since only authorized and authenticated biographical sketches appear in this revisions of *Who's Who in Engineering*. None of the data appearing in previous issues was used without being previously submitted to the individual engineers for correction and approval.

Those who desire a copy of this new edition should place their orders at once with the Lewis Historical Publishing Company, County Trust Building, Eighth Avenue and 14th Street, New York.

Bargain Prices in the Construction Field

An unidentified release has recently been received which appears to have information which, if correct or even approximately so, is of value. Because it concerns largely the work of the civil engineer it has been here abstracted for the benefit of readers.

Whether it is a barn, a skyscraper, a road, or a schoolhouse that is being built today, construction costs are from one-fourth to one-half lower than they were a few years ago, according to a recent estimate. This is traceable to the lower costs of building materials, the widespread unemployment situation, and the keen competition between construction firms due to subnormal building.

To cite examples, in 1929 a 300-room hotel was built in Georgia at a cost per room of about $4,000. Today, a new 16-story hotel in the same state, with 183 rooms, will be built and furnished at a cost of $2,700 per room. In another town in that state, it was planned to build a bridge costing $115,000. However, the drop in construction prices indicated the possibility that the city might be able to afford a better bridge. Even with the changes in specifications that made provision for a more desirable structure, the contract was let for $80,000, a bargain price.

Recently bids were taken on an extension, from 22nd to 38th streets, of New York City's West Side elevated highway. The successful bidder was nearly $400,000 below the engineer's final cost estimate of $1,131,000, and the highest bidder was more than $100,000 below the same estimate. Post-office buildings are, in some instances, being built for less than half the Government appropriation for the purpose. A five-mile section of the National Road in Ohio is being paved to a width of 30 ft. at a cost of $144,000, which is over $50,000 less than the estimated cost of the project. Individuals who have saved to buy or build homes may find it a long time before the present building prices are again obtainable.

Construction work requires more hand labor than nearly any other industry. For this reason, municipalities which are turning their attention to public improvements will be enabled to provide large numbers of men with work. Kansas City and Jackson County, Mo., together, have recently voted the sum of $40,000,000 for public improvements to range from pavements to court-houses. Studies indicate that, of this amount, fully $30,000,000 will find its way in the next few years into the hands of the working classes. It was stated in the bond-issue campaign that the annual extra taxation ensuing to a carpenter, for instance, by this project would be about $10, or the equal approximately of a day's pay. However, that carpenter could expect many extra days of work during the year as a result of the expanded construction program.

In the face of today's low costs, countless public improvement projects which would require many workmen are still in the paper stage. The Public Works Section of the President's Committee on Unemployment Relief, since last December has had reported to it over $6,000,000,000 worth of planned public work. This sum is made up of projects valued at $25,000 and over, which are definitely contemplated but not yet in the pick-and-shovel stage. During the first half of the year, it is estimated that contracts have been let for only $2,000,000,000 worth of these projects. In many cases the money has been made available, but local conflicts

and red tape have held up the actual work. Men need work and taxpayers should recognize their opportunity in bargain prices.

A Close Call

SINCE engineers are essentially pioneers, they often have to expose themselves to personal dangers as a part of the day's work. You may have had an interesting experience of overcoming a difficulty in an unusual situation, or a narrow escape. The Committee on Publications will be glad to receive and consider accounts of such experiences for appearance in these columns.

The professional records of the Society sometimes contain interesting bits of personal information which are at least a variation from the time-honored chronological narrative of the professional events in an engineer's life. One such sketch, written 25 years ago by a friend of the late Emile Low, M. Am. Soc. C.E., has been unearthed from the Society files and, with some deletion, is quoted here.

"When the Mexican Central Railroad was being built, in the early 'eighties,' Mr. Low was a member of the engineers corps. Among those with whom he came in contact during his service in Mexico was a young German who was acting as agent for the sale of dynamite for use in blasting. There were silver mines in the vicinity, and the agent was trying to sell his product to the promoters of these mines. In fact, he did dispose of some of the dynamite in this way. He was also desirous of getting the railroad company for a customer and, for that reason, wished Mr. Low to witness a demonstration of the power of the explosive.

The agent was not familiar with the manner of using the dynamite, but he had in his employ a man who was. Several times he called upon Mr. Low and asked him to accompany him for the purpose of witnessing the result of a blast, but each time the engineer had some engagement which prevented. The fact was that he did not wish to encourage the agent to think that he could make a sale to the railroad company. Also, he had a fairly thorough knowledge of the force of dynamite explosions and had no desire to become more intimately acquainted with them. But the agent was so persistent that finally he consented to accompany him to a mine where there was to be an explosion.

"Since the man who was to set off the dynamite was not on hand, the agent determined to do it himself. They had gone a distance of several hundred feet into the mine. The place where the explosion was to be made was in a chamber of the mine, which was dug out of the solid rock. Holes had been drilled in the floor, and the dynamite was placed in these holes.

"Having never before seen a silver mine, Mr. Low was busy looking about the premises outside the chamber. When he entered it, he was horrified to see the dynamite agent and a number of helpers tamping the explosive into the holes with an iron bar. He shouted to them to stop or they would blow the whole outfit up, but by the time the words were out of his mouth the explosion came. Mr. Low stood with his back against the wall a few feet from the hole where the explosion took place. It was terrific in its effect. There were a number of men in the chamber at the time. Some had their arms and legs torn off, and others were maimed in various other ways and blinded. Several were killed outright.

"Particles of the quartz rock lodged in Mr. Low's face, and the rim of the sombrero that he wore looked as though a charge of shot had been fired through it. His face was badly cut, and the blood streamed from many wounds. Luckily his eyes escaped. A native surgeon extracted all the bits of rock except one, which had passed almost through one of his cheeks. He carried this piece for some time, but finally had it extracted. Since it was largely composed of silver, he had it mounted in a piece of jewelry which he wore for a time, until he lost it. As a result of the explosion, he was laid up for several months. And his face still bears the scars of the occasion, which was his closest call."

Mr. Low's friend did not say what happened to the "agent."

Leonardo da Vinci, 1452–1519

Born in the fortified mountain village of Vinci, near Florence, Leonardo da Vinci was the oldest child of a Florentine lawyer and the only one of the large family whose fame history records. He was in the prime of life when Columbus discovered America and he engaged in many speculative discussions with explorers, among them Amerigo Vespucci. There seem to be no branches of human knowledge that he did not explore; he left few things unattempted, and he was successful to a remarkable extent in all that he undertook. Seldom has nature been more lavish in her endowment than on Leonardo. Remarkable in his strength, he was capable of bending horseshoes and twisting door knockers, yet his hands were slender and shapely like those of a woman, and his touch was delicate enough to paint a Madonna.

As an artist and a contemporary of Michael Angelo and Raphael, he is best known for his "Last Supper" and the "Mona Lisa," which are among the most valuable paintings in existence today. The titles of anatomist, mathematician, chemist, geologist, botanist, astronomer, and geographer applied to him are fully justified by the 5,000 pages of manuscript which he left, most of which are carefully preserved in London, Paris, and Milan.

His engineering ability was of a high order. Many of his ideas were far ahead of his time. After devoting much study to the flight of birds, he developed a man-driven airplane, with which he hoped to give his contemporaries wings. At the age of 28 he went to the East as engineer to the Sultan of "Babylon," or Cairo. In later years he planned an extensive irrigation system for the plains of Lombardy, drained swamps, and improved canal locks. He built that wonderful canal, 200 miles in length, which conducts the waters of the Adda to the City of Milan. In 1500 he entered the service of Caesar Borgia as architect and engineer, and 9 years later he was busy constructing a quay for the disembarkment of boats from San Cristoforo to Milan. As a military engineer his engines of war were marvelous mechanical contrivances. He is credited with the invention of the "tank," the machine gun, and the breech-loading cannon.

On page 1163 of this issue are some reproductions of his original sketches, showing plans for the layout of a town. Space limitations have made it desirable to reduce them to about one-half their original size. In his own words, he describes these plans for a town with a system of high-level and low-level roadways as follows:

"The roads *m* are 6 braccia [the length of an arm] higher than the roads *p s*, and each road must be 20 braccia wide and have $^1/_2$ braccio slope from the sides toward the middle; and in the middle let there be at every braccio an opening, one braccio long and one finger wide, where the rain water may run off into hollows made on the same level as *p s*. And on each side of the extremity of the width of the said road let there be an arcade, 6 braccia broad, on columns; and understand that he who would go through the whole place by the high-level streets can use them for this purpose, and he who would go by the low level can do the same.

"By the high streets no vehicles and similar objects should circulate, but they are exclusively for the use of gentlemen. The carts and burdens for the use and convenience of the inhabitants have to go by the low ones. One house must turn its back to the other, leaving the lower streets between them. Provisions, such as wood, wine, and such things are carried in by the doors *n*, and privies, stables, and other fetid matter must be emptied away underground. From one arch to the next must be 300 braccia, each street receiving its light through the openings of the upper streets, and at each arch must be a winding stair on a circular plan because the corners of square ones are always fouled; they must be wide, and at the first vault there must be a door entering into public privies and the said stairs lead from the upper to the lower streets, and the high level streets begin outside the city gates and slope up till at these gates they have attained the height of 6 braccia. Let such a city be built near the sea or a large river in order that the dirt of the city may be carried off by the water."

Other sketches shown there indicate his plan for canals and streets inside a town, by which the cellars of houses were to be made accessible in boats.

While these plans may be of little value under present conditions, for modern transportation facilities, yet it is of interest to note that for conditions existing over four centuries ago his ideas were indeed advanced.

When Leonardo died, in 1519 at the age of 67, he was in the employ of Francis I, King of France. At the time he was engaged on plans for developing lands in the vicinity of Romorantin and Villefranche

with the waters of the Loire and Cher. According to Benvenuto Cellini, Francis I said that he did not believe any other man had come into the world who had attained so great a knowledge as Leonardo, not only as a sculptor, painter, and architect but, far beyond that, as a profound philosopher.

Credit for the sketches and translations of the manuscripts is given to "The Literary Works of Leonardo da Vinci," by J. P. Richter, 1883.

NEWS OF ENGINEERS

From Correspondence and Society Files

André Roos has been placed in charge of the Engineering Department of the S.F.A.R., French Subsidiary of the Standard Oil Company of New Jersey. In order to fill this appointment, Mr. Roos was transferred from the Hydro Engineering and Chemical Company of Elizabeth, N.J.

John A. Steel, Structural and Contracting Engineer with offices in Knoxville, Tenn., is now associated with Thomas D. Lebby for the practice of engineering and construction in that city.

F. Y. Tsai, formerly a Professor of Architectural Engineering at the College of Engineering, Northwestern University, Mukden, China, is in the Department of Civil Engineering at the National Tsing Hua University, Peiping, China.

E. Randolph Kent, Engineer of Building Construction, State of New York Department of Public Works, was formerly a Hydraulic Engineer with the Long Island State Park Commission at Babylon, N.Y.

Albert W. Luhrs, until recently Director of Research for the Paperboard Industries Association in Chicago, is in Paris where he is connected with the Laboratoire Général pour Emballages.

J. C. Balcomb, who, in the past, has been connected with the Allied Engineers, Inc., in New York City, is now an engineer with the Sioux City Gas and Electric Company at Sioux City, Iowa.

Nicholas S. Hill, Jr., President of the Hackensack Water Company, will make a study of the Shanghai water supply in behalf of the Shanghai Municipal Council.

Burton Smith is at present in Hollister, Idaho, where he is acting in the capacity of Superintendent of the Salmon River Canal Company, Ltd. Previously Mr. Smith was Superintendent of the Glenn-Colusa Irrigation District at Williams, Calif.

Ralph G. Davis, who was Engineer in Charge of the Projects Department, U.S. Engineer Office in Wilmington, Del., is now an Engineer on the Beach Erosion Board, Office of the Chief of Engineers, Washington, D.C.

Aaron Stanton Zinn has opened an office for the practice of consulting engineering in Los Angeles, Calif. Formerly Mr. Zinn was with the Sanitation Department of Los Angeles County.

John M. Hadsall, until recently Architect's Representative for Voorhees, Gmelin, and Walker, of New York City, is now employed on structural design by the Leonard Construction Company of Chicago.

Philip F. Stephens, of Rochester, has become associated with W. S. Barstow and Company, Inc., of that city. He was previously connected with the Rochester Gas and Electric Corporation.

Edmund Feldman is now a Consulting Engineer in Logan, Utah. Until recently Mr. Feldman was in the Bridge Engineer's Office in Boise, Idaho.

Eric Haquinius has left the Aerotopograph Corporation of America to become connected with the Curtiss-Wright Flying Service in Pennsylvania.

C. S. Conrad, formerly President of the Oil and Gas Engineering Company in New York City, has moved to Houston, Tex., where he is associated with Mattison and Davey, Accountants and Auditors.

L. A. Greenley, who has been associated with the Electric Bond and Share Company in New York City, is now an Engineer with the Compañia Anglo Argentina de Electricidad, in Buenos Aires.

James P. McKean, Instructor in Civil Engineering at Iowa State College, has resigned to become associated with the State of Iowa Securities Department as Valuation Engineer.

B. S. Merrill, formerly the Secretary-Treasurer for C. A. Wilmore and Associates, in Birmingham, Ala., has opened an office in that city for the practice of engineering.

J. W. Kelly is in the Engineering Extension Department at Purdue University. Previously, Mr. Kelly was an Engineer for the Portland Cement Association in Minneapolis.

Marshall S. Wright has resigned his position as Sales Engineer and Western Representative of the Aerotopograph Corporation to become affiliated with the Mapping Division of the Curtiss-Wright Flying Service.

C. E. Grunsky, President of the American Engineering Council, has been appointed a member of President Hoover's Organization on Unemployment Relief.

Creighton D. Bickley has accepted the position of Township Engineer of Milburn, N.J.

H. J. Collins, previously in the Engineering Department, University College, University of London, England, is now a member of the firm of Collins and Mason, Consulting Engineers, in Westminster, London.

Ellsworth L. Filby, who was formerly Chief Engineer and Director of the Bureau of Engineering of the Florida State Board of Health, is now associated with Black and Veatch, Consulting Engineers, of Kansas City, Mo.

John C. Harrold, former Assistant Hydraulic Engineer at the U.S. District Engineers' Office in Baltimore, is at present an Assistant Engineer with the Upper Mississippi Valley Division, U.S. Engineers' Office, St. Louis.

Ralph J. Reed, a Consulting Engineer in Los Angeles, Calif., has been appointed a member of the California State Board of Registration for Civil Engineers.

Rufus W. Putnam, previously President of the Maritime Engineering Corporation in Chicago, has been appointed Director of the Chicago Regional Port Commission.

S. F. Crecelius, at one time City Engineer of El Paso, Tex., is now in San Benito, Tex., where he is an Engineer of the International Water Commission.

Charles K. Cadman, of San Francisco, having consolidated his insurance brokerage office with that of Grant-Birkholm and Company, Inc., is now available for employment as a safety engineer.

J. Perry Yates, formerly associated with the Shell Oil Company of Berkeley, Calif., as a Structural Designer, has been appointed Office Engineer for Six Companies, Inc., Hoover Dam Contractors, with headquarters at Boulder City, Nev.

Frederick H. Tibbetts, a Consulting Engineer in San Francisco, Calif., has been engaged by the Santa Clara Water Conservation District to prepare a water conservation plan for the entire Santa Clara Valley, California.

George J. Davis, Jr., Dean and Professor of Civil Engineering at the University of Alabama, has been the recipient of the degree of Doctor of Science, conferred upon him by that university on May 11.

John K. Flick is connected with the Inter-American Highway at Balboa, Canal Zone. Prior to this, Mr. Flick was Assistant Chief Engineer, Carretera al Atlantico at San José, Costa Rica.

Elmo G. Harris, for approximately 40 years on the faculty of the School of Mines and Metallurgy, at the University of Missouri in Rolla, will retire at the end of the present school year.

Joe B. Butler has been promoted from Associate Professor to Professor of Civil Engineering in charge of the Department of Civil Engineering at the Missouri School of Mines at Rolla.

R. W. Stiles, formerly an engineer of San Antonio, Tex., is now associated with the Missouri Valley Pipe Line Company, in Ellsworth, Kans.

Makoto Sato, who was an Assistant Engineer at the Department of Interior, Government General of Korea, in Seoul, Korea, is now with the Bureau of Public Service, Government General of Chosen, Keijo, Chosen.

Wallace B. Evans, who in the past has been Job Engineer for United Engineers and Contractors, Inc., in Philadelphia, now has the same position with the Societé Franco-Américaine de Raffinage, Port Jerome, S.I., France.

Ray E. Mackenzie, who has lately been engaged on an investigation of the water resources of the Susquehanna River Basin, has transferred from the Baltimore U.S. Engineer District to the Upper Mississippi Valley Division at St. Louis.

B. J. KAISER has formed an association to be known as Kaiser, Neal, and Reid, Architects, to continue the architectural practice of the late Carlton Strong, in Pittsburgh, Pa.

H. J. GAULT, who is a Construction Engineer, U.S. Bureau of Reclamation, is in charge of the construction of the Cat Creek Dam for the Navy Department at Hawthorne, Nev.

THOMAS LEAHY is Resident Engineer for the Fort Worth and Denver Northern Railway, on the construction of their 110-mile line between Childress and Pampa, Tex.

I. AUSTIN KELLY III, who has been Chief Engineer and General Manager of the H. S. Stevens Company, Inc., in Rye, N.Y., has been appointed President of the Rye Construction Corporation.

ROBERT S. THOMAS, Lieutenant-Colonel, Corps of Engineers, U.S.A., will study at the Army War College, in Washington, for one year.

GORTON W. BRUSH, former Structural Engineer with the Allied Engineers, Inc., has become associated with the State Highway Department, in Lansing, Mich., as Bridge Designer.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From August 8 to September 9, 1931

ADDITIONS TO MEMBERSHIP

BARRON, MAURICE (Jun. '31), 73 Elmont Ave., Port Chester, N.Y.

BARROW, ASA CARRINGTON (Assoc. M. '31), Asst. Prof., Civ. Eng., Alabama Polytechnic Inst., Box 2276, Auburn, Ala.

BERRY, CARL MORRISON (Jun. '31), Draftsman, Weyerhaeuser Timber Co., Box 576, Tacoma, Wash.

BILDE, NILS TAGE RAGNVALD (M. '31), Gen. Mgr., Swedish Portland Cement Assoc. (Res., Järpstigen 11 Älsten), Stockholm, Sweden.

BLAIR, THOMAS JACKSON, JR. (M. '31), 355 River Ave., Weston, W.Va.

BOND, CHARLES FORREST (Assoc. M. '31), Statistician, State Highway Dept., Atlanta (Res., 515 West Walker Ave., College Park), Ga.

BONNER, DAVID (M. '31), Constr. Engr., Rodgers & Hagerty, Inc., 70 East 45th St., New York (Res., Loudon Woods, Rye), N.Y.

BOWERS, SAMUEL WARREN (Jun. '31), Engr. and Surv. (MacKenzie & Bowers), Box 620, Southington, Conn.

BRACKETT, WOODBURY EDMUND (Jun. '31), Town Mgr., Washburn, Me.

BRANSFORD, THOMAS LEROY (Assoc. M. '31), Div. Materials Engr., State Dept. of Highways and Public Works, Chattanooga, Tenn.

BRAY, DWIGHT HUBERT (Assoc. M. '31), Asst. Engr. of Maintenance, State Highway Dept. (Res., 218 Steele St.), Frankfort, Ky.

BROWN, W. LARRY (Assoc. M. '31), 30 South Ingram St., Henderson, Ky.

BURNS, CHARLES PHILLIPS (Jun. '31), Chf. of Party, Flood Control Survey, U. S. Engrs., 607 Postal Telegraph Bldg., Kansas City, Mo.

BUSSEY, BYRON CHAPMAN (M. '31), Deputy Commr. of Public Works (Res., 179 Amherst Ave.), Pawtucket, R.I.

CALHOUN, CHAD F. (Assoc. M. '31), 1522 Latham Sq. Bldg., Oakland, Calif.

CAMP, CECIL SIDNEY (June. '31), R.F.D. No. 1, Stuttgart, Ark.

CAMPBELL, BENJAMIN LUCIEN (Assoc. M. '31), Asst. Civ. Engr., U.S. Engrs., U.S. Engrs. Office (Res., 321 Customhouse), Portland, Ore.

CAMPBELL, THOMAS HAYS (Assoc. M. '31), Supt. of Constr., Stone & Webster Eng. Corp., 324 Central Terminal Bldg., Seattle, Wash.

CASEY, FORREST MCKENDREE (Assoc. M. '31), Asst. Engr., City Eng. Dept. (Res., 4212 West 2d St.), Los Angeles, Calif.

CHAN, LEUNG SHI (Assoc. M. '31), Chf. Engr., Municipal Water Works, Canton, China.

CHAVEZ-OROZCO, JESÚS (Assoc. M. '31), Engr., J. G. White Eng. Corp.; Av. Uruguay 73, Desp. 3, City of Mexico, Mexico.

COOMBS, THOMAS (M. '31), Director-Mgr., City Planning Comm., 758 North Ave. 66, Los Angeles, Calif.

EVANS, LLEWELLYN (M. '31), Supt. of Lighting, City of Tacoma (Res., 3612 North 33d St.), Tacoma, Wash.

EYQUEM, LOUIS BIAUT (M. '31), Prof., Univ. of Chile; Chf. Designing Dept., National Reclamation Bureau, Casilla 745 (Res., Av. Blanco Encalada 1965), Santiago, Chile.

FABRI, JOSEPH (Assoc. M. '31), Asst. to Squad Leader, The New York Edison Co., New York (Res., 2229 Ocean Ave., Brooklyn), N.Y.

FITZGERALD, WALTER (Jun. '31), Draftsman, Jackson & Moreland, 115 Ferry St., Hoboken (Res., 26 Van Ness Pl., Newark), N.J.

FRAZIER, ARTHUR HENRY (Jun. '31), Asst. Engr., U.S. Geological Survey, 202 Old State Capitol, St. Paul, Minn.

GALLAGHER, ALFRED CHAPIN (Assoc. M. '31), Supt., Turner Constr. Co., New York (Res., 2020 Voorhies Ave., Brooklyn), N.Y.

GELDER, IRVING LEWIS (M. '31), Vice-Pres. and Owner, Corson Constr. Corp. (Res., 300 Central Park West), New York, N.Y.

GOSHEN, THEODORE (Jun. '31), Asst. Civ. Engr., State Highway Dept. (Res., 195 Academy St.), Jersey City, N.J.

HALL, LESTER GEORGE (Jun. '31), Civ. Engr., McLaughlin, Noreen & Co., Huron (Res., 221 Eighth Ave., S.E., Aberdeen), S.Dak.

HARDING, GEORGE HOSKEN (Assoc. M. '31), Member of Faculty, Speed Scientific School, Univ. of Louisville, Louisville, Ky.

HARMELING, KARL CLYCE (Jun. '31), Care, U.S. Bureau of Roads, Badger, Calif.

HODECKER, WILLIAM FREDERICK, JR. (Jun. '31), 59 Scheerer Ave., Newark, N.J.

HOUSECROFT, MAURICE (Assoc. M. '31), Chf. Bridge Engr., State Road Comm., 421 State Capitol, Salt Lake City, Utah.

HUBER, WILLIAM CALVIN (Jun. '31), Draftsman, State Highway Comm., Bridge Dept., 946 Convention, Baton Rouge, La.

JACOBS, IRVING (M. '31), Asst. to Chf. Designing Engr., Board of Transportation, 250 Hudson St., Room 605, New York, N.Y.

LANGE, WILLIAM HOBART (Assoc. M. '31), Salesman and Constr. Engr., Bark River Bridge & Culvert Co., Bark River, Mich. (Res., 917 Fourth St., West DePere, Wis.).

LEWIS, MORGAN MILES (Assoc. M. '31), Engr., Right of Way, San Francisco Water Dept., City and County of San Francisco, 425 Mason St., San Francisco (Res., 521 Lincoln Ave., San Rafael), Calif.

LOUCKS, GLENN RUSSELL (Assoc. M. '31), 3015 Seminary Ave., Oakland, Calif.

MCGEE, JAMES HERMAN TAYLOR (Jun. '31), Asst. Office Engr., Florida Development Co., Everglades, Fla.

MCLAUGHLIN, THOMAS PERRY, JR. (Jun. '31), Instrumentman, N.Y.C.R.R., New York, N.Y. (Res., 226 Aldene Rd., Roselle, N.J.)

MAINEY, JAMES HENRY (Jun. '31), Pres., The J. H. Mainey Eng. Co., Room 1, Cleveland Trust Bldg., Painesville, Ohio.

MARSHALL, WILLIAM (Assoc. M. '31), Insp., State Highway Comm., 401½ East Main St., Richmond, Va.

MAY, JOHN WALTER (M. '31), Gen. Supt. and Constr. Mgr., United Engrs. & Constructors, Inc., 112 North Broad St., Philadelphia (Res., 469 Hamsphire Rd., Drexel Park), Pa.

MESSER, MERTON WILLIAM (Jun. '31), 1804 Tulip St., Baton Rouge, La.

MONKS, JOHN, JR. (Jun. '31), 438 Broadway, New York, N.Y.

MURPHY, RAYMOND WILLIS (Assoc. M. '31), 38 Parker St., Port Chester, N.Y.

NELSON, ELMER KINGSHOLM (M. '31), City Engr., Box 403, Laramie, Wyo.

NELSON, WALDEMAR JAMES (Assoc. M. '31), Res. Engr., U.S. Bureau of Public Roads, Dist. 2, Kanab, Utah.

NOYES, HAYDON THOM (Jun. '31), Designer, Chanin Constr. Co., 122 East 42d St., New York (Res., 1 Odell Pl., New Rochelle), N.Y.

OLSON, JOHN ARTHUR (M. '31), Pres., Fred F. French Management Co., Inc., and Fred F. French Investing Co., Inc., 551 Fifth Ave., New York, N.Y. (Res., 6 Abbey Rd., Darien, Conn.).

OVERSTREET, CHESTER ZEARL (M. '31), 1434 Evergreen Ave., Plainfield, N.J.

PARENT, AMAND (Assoc. M. '31), Design Draftsman for Public Works, Navy Yard, Puget Sound, Bremerton, Wash.

PATTON, MARION CECIL (Assoc. M. '31), Chf. Engr., Armco Culvert Mfrs., Ass'n. Middletown, Ohio.

PEARCE, FLETCHER WILLIAM (Assoc. M. '31), Instr., Southern Methodist Univ. (Res., 3433 Haynie Ave.), Dallas, Tex.

POSS, ROBERT JOSEPH (Jun. '31), with U.S. Engr. Office, 406 Federal Bldg., Milwaukee, Wis.

ROBINSON, THOMAS WILLIAM (Assoc. M. '31), Asst. Engr., U.S. Geological Survey, Washington, D.C.

SLATER, HAROLD HERBERT (Jun. '31), R.R. 1 Smithville, Ohio.

STRONG, CHARLES CYPRIAN, II (M. '31), Insurance Engr., C. & O. Ry. and P.M. Ry., 3400 Terminal Tower, Cleveland, Ohio.

VAKSVIK, KNUTE NICHOLAS (Assoc. M. '31), with U.S. Geological Survey, 225 Federal Bldg., Honolulu, Hawaii.

VENTURA, GREGORY (Jun. '31), 60 Atlantic Ave., Freeport, N.Y.

VIDAL, SEVERO (Assoc. M. '31), Chf. Engr., of Reclamation Bureau of Chile (Res., Delicias 1149-C), Santiago, Chile.

WALLACE, DONALD SANFORD (Assoc. M. '31), Dist. Engr., U.S. Geological Survey, Ocala, Fla.

WEBSTER, JAMES MCBARRON (Assoc. M. '31), 401 West End Ave., New York, N.Y.

WHEATLEY, WILLIAM GEOFFREY (Assoc. M. '31), care, Irrig. Secretariat, P. W. D., Lahore India.

WHITAKER, GEORGE ELMER, 2d. (Jun. '31), 1612 East Genesee St., Syracuse, N.Y.

WICK, GEORGE ALLEN (Assoc. M. '31), with Rosslyn Steel & Cement Co., 5023 Illinois Ave., N.W., Washington, D.C.

WILLIAMS, WYATT EDWIN (Jun. '31), 1303 Market St., Berwick, Pa.

Willis, Robert Mills (Assoc. M. '31), Constr. Engr., State Highway Comm., Div. 4, Box 231, Chanute, Kans.

Woodin, Mark Stevens (Assoc. M. '31) Bridge Designer, Office of Bridge Engr., State Highway Dept. (Res., 302 Nineteenth Ave., W.), Olympia, Wash.

Young, Kenneth Roscoe (M. '31), Senior Engr., in Chg., Western Area, Vicksburg Engr. Dist., Box 47, Monroe, La.

Membership Transfers

Alderson, George France (Assoc. M. '25; M. '31), Vice-Pres. and Treas., William M. Francis Co., du Pont Bldg. (Res., 2427 Delaware Ave.), Wilmington, Del.

Boblow, Reuben (Jun. '23; Assoc. M. '31), Care, Robinson & Steinman, 117 Liberty St., New York, N.Y.

Deignan, John Eugene (Jun. '26; Assoc. M. '31), 30 South Munn Ave., East Orange, N.J.

Germain, Eduardo, Jr. (Jun. '20; Assoc. M. '31), Mgr., Germain & Germain, Ltda., Calle Bdlnes No. 79, Santiago, Chile.

Harding, Ralph Lyman (Assoc. M. '13, M. '31), William Watson & Associates, 4614 Prospect Ave. (Res. 3350 Elsmere Rd., Shaker Heights), Cleveland, Ohio.

Litt, Morris Robert (Jun. '26; Assoc. M. '31), 1314 Twentieth Ave., Longview, Wash.

Lund, Gabriel Emanuel Frimann (Assoc. M. '21; M. '31), Supt. of Tanamo R. R. and Marine Supt., Atlantic Fruit & Sugar Co., Central Tanamo, Cayo Mambi, Oriente, Cuba.

Miller, Arthur Phillips (Jun. '27; Assoc. M. '31), Senior Civ. Eng. Draftsman, Detroit Dept. of Water Supply, 8100 West Warren Ave., East Dearborn (Res. 13941 Cloverlawn Ave., Detroit), Mich.

Needham, Robert Stephen (Assoc. M. '17; M. '31), 9 Ravenlea Rd., Folkestone, Kent, England.

Ouda, Albert, Jr. (Jun. '23; Assoc. M. '31), Structural Engr., Voorhees, Gmelin & Walker, 101 Park Ave., New York (Res., 106 Highland Ave., Yonkers), N.Y.

Peterson, Hilmer Frederic (June. '27; Assoc. M. '31), Acting Chf. Draftsman, Survey and Drafting Dept., Shell Oil Co., 521 Higgins Bldg., Los Angeles (Res., 1945 Fremont Ave., South Pasadena), Calif.

Stephenson, Lowell Joseph (Jun. '29; Assoc. M. '31), Res. Engr., Ralph A. Beebee, San Francisco (Res., 1092 Keith Ave., Berkeley), Calif.

Woodward, Harold Stone (Jun. '23; Assoc. M. '31), Structural Engr., E. R. Seelye, 101 Park Ave., New York (Res., 1128 Clay Ave., Pelham Manor), N.Y.

Reinstatements

Camp, Eugene Vernon, M., reinstated Aug. '31.

Deaths

Albright, John Joseph. Elected F., Apr. 20, 1886; died Aug. 20, 1931.

Billingsley, James Wartelle. Elected Assoc. M., May 6, 1908, M., June 24, 1916; died Aug. 17, 1931.

Gallivan, James Henry. Elected Assoc., M., Jan. 2, 1912; died Feb. 12, 1931.

Hughes, Thomas Rogers. Elected Jun., Nov. 15, 1926; died Aug. 2, 1931.

McHenry, Edwin Harrison. Elected M., Feb. 5, 1896; died Aug. 21, 1931.

Marshall, Horace Miller. Elected M., Dec. 3, 1890; died Oct. 3, 1930.

Ober, Ralph Hadlock. Elected M., Dec. 4, 1907; died Aug. 30, 1931.

Preston, Harry Longyear. Elected Assoc. M., Apr. 7, 1908; M., Oct. 3, 1922; died Mar. 25, 1930.

Raymer, Albert Reesor. Elected M., Mar. 1, 1910; died Aug. 10, 1931.

Resmaw, Charles Wallace. Elected Assoc. M., Aug. 28, 1922; died June 10, 1931.

Wagner, Samuel Tobias. Elected M., Feb. 2, 1887; died Aug. 7, 1931.

TOTAL MEMBERSHIP AS OF SEPTEMBER 9, 1931

Members	5,902
Associate Members	6,383
Corporate Members	12,285
Juniors	2,738
Honorary Members	15
Affiliates	133
Fellows	5
Total	15,176

Men and Positions Available

These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 97 of the 1931 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.

Men Available

Civil Engineer; Jun. M. Am. Soc. C.E.; 24; single; graduate, 1929; 1½ years surveying; 1 summer's work with construction company; desires work on construction, drafting, or surveying. Available at once. C-8544.

Civil Engineer; Jun. Am. Soc. C.E.; graduate of Columbia University—A.B., 1928 and C.E., 1930; experience in New York City construction and topographic surveying. C-9691.

Civil Engineer; Jun. Am. Soc. C.E.; 28; married; graduate; 6 months industrial appraisals; 2½ years as draftsman in field, lock, and dam construction; 1 year topographic and hydrographic mapping, field, office, and highway plans. Available on short notice. Middle West preferred. C-9708.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 36; married; graduate, Massachusetts Institute of Technology; 11 years experience in design, supervision, and construction of bridges, buildings, and waterfront terminals, including responsible charge; also 3 years experience teaching engineering subjects. Responsible position in design or supervision of construction, or assistant professorship desired. C-9716.

Structural Engineer; Jun. Am. Soc. C.E.; 23; single; B.S., architectural engineering, 1927, and M.S., structural engineering and mathematics, 1931, Iowa State College; 6 months reinforced concrete detailing; 2 years experiment station; reads French and German; good draftsman. Instructorship, or position in structural design, drafting, or research desired. C-9731.

Cost Reduction Executive; Assoc. M. Am. Soc. C.E.; A.S.M.E.; college graduate; nearly 20 years experience in general industrial, utility, municipal, mining engineering, and construction work; moderate salary; can reinvest part of salary. Small progressive organization preferred. Would consider consulting, part-time, non-competing units. Widely experienced in the East, North, and South. C-7486.

Graduate Engineer; Assoc. M. Am. Soc. C.E.; 28; married; 5 years experience in construction of steam and hydro-power plants up to 50,000-kw. capacity; also experience on substation and transmission line construction. Desires permanent position with progressive construction company or consulting engineer. Location immaterial. Available at once. C-9742.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 15 years experience—10 in executive capacities in design and construction of all types of bridges, steel and concrete structures, foundations contact, and publicity in consulting field. Desires permanent connection with opportunities, preferably in South or Southeast, but will go anywhere. Available on short notice. C-2573.

Executive Engineer; M. Am. Soc. C.E.; 20 years experience; design and construction of all classes of public utility structures, investigations, reports, valuations and economic studies, public relations and management, hydro, steam, gas, and water works. A-1137.

Civil Engineer; Jun. Am. Soc. C.E.; 31; married; graduate; 6 years experience on reinforced concrete and structural steel buildings; 2 years experience in surveying. Desires position as assistant superintendent or field engineer. Available at once. B-8865.

Sanitary Engineer; Jun. Am. Soc. C.E.; S.M., Massachusetts Institute of Technology, 1926. Experienced in design of sewers, disposal plants, water supply, filtration, and pumping stations; also in design and construction of waterfront improvements, subaqueous foundations, and river and harbor developments. Excellent theoretical training in sanitation and public health work. Desires connection with consulting engineer's office, health department, or municipal construction. Location immaterial. C-3290.

Junior Civil Engineer; resident of New York State; B.S. degree in C.E., 1931; desires work—preferably in highway location and construction. Excellent references. Location immaterial. C-9685.

Structural Designer; American; married; graduate, Massachusetts Institute of Technology; 4 years experience on design and detail of office and mill buildings; working knowledge of advanced structures, soil mechanics, foundations, and welded steel structures. Willing to locate in Chicago or East. C-9746.

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; graduate, 1930; 1½ years experience inspecting sand and gravel for highway material; responsible for record books, computations on grading, drainage, and bridge projects; in charge of beam breaking crew research project. Location immaterial. Connection with engineering or contracting organization desired. C-9769.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 33; single; graduate; 10 years experience—2 years mechanical, 8 years structural—on design of steel and reinforced concrete structures, bridges, buildings, superstructures and foundations, and harbor piers. C-8214.

Civil Engineering Graduate, 1931; desires position, preferably in building construction work. Has worked as carpenter and laborer on residence construction work in Westchester County during school vacation periods since 1926. Will take position anywhere, but prefers to be located in or near New York City. C-9745.

Civil Engineer; Jun. Am. Soc. C.E.; 28; married; Carnegie graduate; 2 years experience in railroad maintenance and construction; 1 year as assistant engineer on airport construction; 1 year on large hydro-electric development on hydraulic computations and surveys; also experience on highway estimates and construction. Location immaterial. Available at once. C-9744.

Civil, Industrial Engineer; M. Am. Soc. C.E.; graduate; licensed; over 20 years experience in design, construction of hydro-electric developments, industrial plants, institutional and housing groups both state and private interests, including all utilities. Experience covers

complete design, supervision of entire work from inception, including preliminary studies, estimates, and mechanical, and architectural work. Highest references. B-2835.

CIVIL ENGINEER, Assoc. M. Am. Soc. C.E.; 37; university graduate; broad experience in all classes of steel and reinforced concrete buildings; teaching, designing, estimating, selling, sales management. Location, Eastern United States or South America; employed at present. C-1170.

GRADUATE CIVIL ENGINEER; 40; married; sales executive structural building products; 12 years experience selling to architects, engineers, and contractors in Chicago and the Middle West; engineering sales position desired. Excellent references. Will consider agency representation from responsible manufacturers. B-2629.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 30; 6 years in general contractor's office with following record: estimating all types of buildings; drafting; designing; supervising work in field; and expediting subcontracts; 3 summers on concrete highway construction; 1 summer on sewer system construction. Excellent references as to ability and personal character. Available immediately. C-1.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; recent graduate, Worcester Polytechnic Institute; 2 years experience timekeeping on concrete bridge substructure work; 1 year bridgeman's helper for two largest steel erectors; also experience in erection of toolhouse of the latter; desires work preferably in construction. Available immediately; location immaterial. C-9800.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience, drafting, design, checking, inspection, and surveys on construction work. Desires connection with construction company, consultant, contractor, or architect; capacity to assume responsibility, and interest to promote productive activity; prefers field engineering, construction, or related work. C-2605.

CIVIL ENGINEER; 27; good health; 1931 graduate; 2 years experience on railroad construction—1 year as engineer for railroad contractor; can handle men; prefers work in a foreign field. C-9810.

CIVIL ENGINEER; 26; single; college graduate; American citizen; 2 years experience in construction and maintenance of highway. Speaks and writes Spanish as well as English. Desires work anywhere but would prefer being with some American company in South America. C-9752.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate; 2 years experience in Cripple Creek, Colo.; designing engineer for city electric lines; designing railway bridge substructures; resident engineer railway bridges; assistant chief engineer of structural iron plant; vice-president of manufacturing plant; a city engineer at time of entering military service; for past 7 years a sales engineer. Employed at present. B-5440.

HYDRAULIC AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 10 years experience; licensed, New York State. Just finished 4 years work with supervising engineers on 20-million dollar power project. Experience covers stream gaging, river diversion, flood control works, earth dam, concrete and side channel spillways, and power plant construction. Will go anywhere for reasonable salary. C-2589.

ENGINEERING, SALES EXECUTIVE; M. Am. Soc. C.E.; many years engineering and sales experience in United States and foreign countries. Speaks Spanish. Last 15 years in United States as district manager negotiating new business for engineering and contracting firm of international reputation. Wide contacts and first class references. Willing to meet reponsible representative in New York City. C-9631.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single; 4 years experience with architect, all types of buildings; steel and concrete design; 2 years with general contractor, time keeping, estimating, costs; 1 1/2 years with large fabricating plants; experience in sales and cost accounting. Desires connection general contractor. C-9750.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 31; married; graduate, Rensselaer Polytechnic Institute; 10 years active experience in field and office, highways, sewers, dams, and long span and movable bridges. Available immediately. Location in eastern United States preferred. Excellent references. C-9826.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 32; married; C.E. and M.C.E. degrees, Cornell University; 1 year as instructor; 8 years in design and construction of all types of buildings; last 4 years engineer in charge, and partner with, consulting engineer, New York. Similar work desired with opportunity for advancement. B-7677.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 87 to 89 of the Year Book for 1931. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

ANCIENT BRIDGES OF THE NORTH OF ENGLAND. By E. Jervoise. London, Architectural Press, 1931. 146 pp., illus., 8 × 5 in., cloth. 5s. 6d.

During the past two years the author has visited all the bridges in the north of England known to have existed prior to the nineteenth century. This attractive little volume describes the existing bridges briefly and gives what is known of their history. Illustrations of the most interesting are included.

BAHNHOFSANLAGEN, II. SAMMLUNG GÖSCHEN BD. 1036. By H. Wegele. Berlin and Leipzig, Walter du Gruyter and Co., 1931. 138 pp., illus., diagrs., tables, 6 × 4 in., cloth. 1.80 r.m.

A concise description of the construction and equipment of railroad stations and terminals. Freight and passenger station buildings, train sheds, shops, and water supply problems are also discussed.

BUILDING ESTIMATOR'S REFERENCE BOOK. 7 ed. By Frank R. Walker. Chicago, Frank R. Walker Co., 1931. 1,527 pp., 7 × 4 in., leather. $10.00.

A comprehensive collection of cost data covering all branches of building construction, with much incidental information upon methods of construction and materials. This edition is said to be completely revised and rewritten.

ECONOMICS FOR ENGINEERS. By E. L. Bowers and R. H. Rowntree. New York, McGraw-Hill Book Co., 1931. 490 pp., diagrs., charts, maps, tables, 9 × 6 in., cloth. $4.00.

This textbook has been written to give engineering students a knowledge of economic principles and problems. The subject is presented very concisely, in order not to burden the curriculum unduly, and the engineering aspects of economic theory and business activity are emphasized. A practical presentation of the subject from an engineering point of view.

ENGINEERING PROBLEMS MANUAL. 2 ed. By F. C. Dana and E. H. Willmarth. New York, McGraw-Hill Book Co., 1931. 252 pp., illus., diagrs., charts, tables, 8 × 5 in. $2.00.

This manual has been prepared primarily for use in the courses in engineering problems, now given at some colleges, to train the beginner in proper habits, effective methods, and systematic workmanship, and to correlate his courses in physics and mathematics with engineering. It contains specifications for computation sheets, advice on habits of work and study, concise notes on fundamental principles and mathematics, 300 practical problems, and a collection of tables. The new edition has been revised and partly rewritten.

ESTIMATING BUILDING COSTS. 3 ed. By F. E. Barnes. New York, McGraw-Hill Book Co., 1931. 656 pp., illus., diagrs., charts, tables, 7 × 5 in., cloth. $5.00.

A handbook for contractors and estimators, which groups the information needed for determining the amount of labor necessary for the various building operations, the current prices of labor and materials, and the cost of replacing buildings built between 1890 and 1926. The data are arranged for quick consultation, usually in tabular form. Labor hours and bills of materials are given. This edition has been thoroughly revised, and new chapters have been added on building insulation, storage silos, circular bins, concrete masonry, and cement gun work. The author is Building Valuation Engineer of the New York Central Lines.

FORTSCHRITTE IM HOCHBAU UND DEREN ANWENDBARKEIT IM ÖSTERREICHISCHEN BAUWESEN. By S. Heidinger. Vienna, Oesterreichischen Kuratorium für Wirtschaftlichkeit, 1931. 127 pp., illus., diagrs., tables, 8 × 6 in., paper. 5.65 r.m.

A survey of modern methods of building construction, especially in Germany, undertaken to ascertain the economic practicability of adopting them in Austria. Modern improvements in materials and methods of construction and contractors' equipment are reviewed, and conditions in the two countries are compared.

INHALTSVERZEICHNIS DER ZEITSCHRIFT DES VEREINES DEUTSCHER INGENIEURE, 1926–1930. Bd. 70–74. Berlin, V.D.I. Verlag, 1931. 138 pp., 12 × 8 in., paper. 8 r.m.

This index, covering the last 5 volumes of the *Zeitschrift*, contains over 3,500 entries to authors and subjects. It is an important guide to recent engineering developments, and especially to the work of German engineers.

JAHRBUCH DER DEUTSCHEN GESELLSCHAFT FÜR BAUINGENIEURWESEN, Bd. 6, 1930. Berlin, V.D.I. Verlag, 1931. 218 pp., illus., diagrs., tables, 8 × 6 in., paper. 12 r.m.

The Year Book of the German Society of Civil Engineers affords a convenient guide to German work in the field of engineering during the past year. Among the subjects discussed are the effectiveness, as a means of transportation, of the canals of northern Germany, current problems in city planning, the influence of the engineer upon modern architecture, recent research in soil physics, and research in wind pressure. A list of doctoral dissertations in civil engineering accepted by German engineering schools during the years 1928–1930 is given, and also a bibliography of books upon civil engineering subjects published in the German language during those years. An interesting feature of the book is a list of all important engineering works, completed during 1929 and 1930 in Germany and Austria, which gives the principal dimensions of each work.

MATERIALS OF CONSTRUCTION. 4 ed. By A. P. Mills. Edited by H. W. Hayward. New York, John Wiley and Sons, 1931. 423 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $4.00.

The aim of this work is to supply a general textbook upon the manufacture, properties, and uses of common engineering materials, for students of engineering. The book is to be supplemented by a laboratory course in the testing of materials. The new edition has been revised and enlarged.

SURVEYING FROM AIR PHOTOGRAPHS. By Capt. M. Hotine. New York, Richard R. Smith, Inc., 1931. 250 pp., drawings, plates, 10 × 7 1/2 in., cloth. $8.

An interesting treatise in which surveying from air photographs is given as a sound alternative to surveying on the ground. The book provides a plain statement of the various processes involved in this new method of surveying and of their practical application. The illustrative photographs given clarify the description of methods and instruments. The information contained in the book is important to anyone interested in a detailed examination of natural and artificial features of the earth's surface.

VORLÄUFIGE ANWEISUNG FÜR ABDICHTUNG VON INGENIEURBAUWERKEN. Von Deutsche Reichsbahn-Gesellschaft. Berlin, W. Ernst & Sohn, 1931. 59 pp., illus., diagrs., tables, 12 × 8 in., paper. 3.60 r.m.

This pamphlet gives detailed methods for waterproofing foundations, retaining walls, bridges, and tunnels, adopted by the German Railroad Company. The approved materials are described, their use illustrated, and methods of testing given.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.

BRIDGES

Concrete Arch. A Study of the Views of Monsieur Freyssinet, T. J. Gueritte. *Structural Engr.*, vol. 9, no. 7, July 1931, pp. 252–255. Discussion of paper previously indexed from June issue of this journal and from *Engineer*, June 12, 1931.

Concrete, Coplay, Pa. Three Types of Spans in One Bridge, B. C. Collier. *Can. Engr.*, vol. 61, no. 1, July 7, 1931, pp. 28–29 and 54, 4 figs. Some unique features of construction incorporated in the bridge over the Lehigh River at Coplay, Pa., using gunite slabs as forms and gunite paneling.

Concrete Girder, Australia. The Design and Construction of Pyke's Creek Bridge, G. O. Thomas. *Inst. Engrs. Australia Journal*, vol. 3, no. 5, May 1931, pp. 173–174. Discussion by B. A. Smith, Steele, Connoly, and Farrent of paper indexed in Engineering Index 1930, p. 230, from issue of Oct. 1930. Author's reply.

Concrete, Great Britain. Some Engineering Works in the Isle of Ely, 1925–1931, R. S. W. Perkins. *Ferro-Concrete*, vol. 23, no. 1, July 1931, pp. 8–36, numerous figs. Inauguration of extensive program of bridge construction and other works; typical examples.

Design. The Design of Modern Bridges, O. M. Ayrton. *Civil Eng.* (*Lond.*), vol. 26, no. 1, June 1931, pp. 25–26, 2 figs. Previously indexed from *Roy. Inst. Brit. Architects Journal*, May 16, 1931.

Gold Beach, Ore. Rogue River Bridge at Gold Beach, Oregon, C. B. McCullough. *West Construction News*, vol. 6, no. 13, July 10, 1931, pp. 341–342, 5 figs. Series of 7 reinforced-concrete arches of 230-ft. span, each flanked at either end by 144 ft. of reinforced concrete girder approach, total length of structure being 1,938 ft.

Iron, Failure. Collapse of a 72-Year-Old Bridge, R. Fleming. *Eng. News-Rec.*, vol. 107, no. 4, July 22, 1931, pp. 149–150. Note on the collapse of the bridge of Lowthorp, trapezoidal truss type, 3 spans of $56^{1}/_{2}$ ft., each with 16-ft. clear roadway and $5^{1}/_{2}$-ft. sidewalk.

Montreal. Du Bois Street Bridge, Montreal, Que., J. F. Brett. *Can. Engr.*, vol. 60, no. 26, June 30, 1931, pp. 9–13, 6 figs. Reinforced-concrete bowstring arch has span of 146 ft. and cantilever arms on either side.

Movable. Safety Features of Movable Railway Bridges, G. M. Heinse. *Ry. Elec. Engr.*, vol. 22, no. 7, July 1931, pp. 183–184 and 193, 5 figs. Equipment and operating mechanisms of railroad and river bridges; traffic safeguarded by circuits controlling sequence of operations.

Plate Girder, Georgia. Experience with Girder-Beam Bridges in Georgia, S. B. Slack, *Eng. News-Rec.*, vol. 107, no. 3, July 16, 1931, pp. 100–101, 9 figs. Practice in girder-beam bridge design; some typical girder-beam bridges; beams versus pony trusses.

Rigid Frame, Brazil. Long Rigid-Frame Bridge Erected by Cantilever Method, R. Schjodt. *Eng. News-Rec.*, vol. 107, no. 6, Aug. 6, 1931, pp. 208–209, 4 figs. Design and construction of Herval Bridge in Sta. Catharina, Brazil, comprising continuous reinforced concrete frame, with main span of 224 ft.; main piers were built as forked columns with girders carried on pin bearings during construction stage; on completion of construction, bearings were embedded in concrete, converting structure into continuous rigid frame; bridge erected by cantilevering in 5-ft. sections, form boards supplying support.

Steel Truss, Suisun Bay, Calif. Unusual Bridge Construction Methods Employed in Building Bridge Across San Francisco Bay. *Pub. Works*, vol. 62, no. 7, July 1931, pp. 31–32, 5 figs. Bridge 5,603 ft. long, containing seven 526-ft. through-truss spans, two deck spans of 264 ft. and 504 ft., respectively, one 328-ft. vertical-lift span, 560 ft. of viaduct at south end, and 220 ft. at north end. See also Engineering Index 1930, p. 238, for similar descriptions.

Trestle. Trestle and Firebreaks on Kansas City Southern. *Eng. News-Rec.*, vol. 107, no. 2, July 9, 1931, p. 69, 2 figs. Hazel Creek trestle of creosoted timber on 23-mile extension of Arkansas Western Railroad; fire-stop concrete piers at intervals are substituted for pile bents.

BUILDINGS

Brick. Designers of Clay Products, C. B. Lovewell. *Brick and Clay Rec.*, July 14, 1931, pp. 16–20, 6 figs. Adaptation of brick to modern design; use of glass; Holland Plaza Building given as an example of standard shapes and sizes.

Concrete. Thesis on the Study of Esthetic Design of Reinforced Concrete on the Continent, H. B. Rowe. *Structural Engr.*, vol. 9, no. 7, July 1931, pp. 241–251, 27 figs. Examples of concrete construction in Germany, Switzerland, France, and throughout the Continent. (Concluded.)

Costs. What Should a Building Cost? M. C. Tuttle. *Contract Rec.*, vol. 45, no. 27, July 8, 1931, pp. 807–808, 7 figs. Determining least expensive construction; solution of typical problem to show how to compare costs of various designs.

High Buildings, Vibrations. The Sway of Tall Towers, D. C. Coyle. *Arch. Forum*, vol. 55, no. 1, part 2, July 1931, pp. 109–112, 3 figs. Width of sway in stiff tower will be less than one-third as much as in lower and more flexible structures; vibration periods and effects; weight versus stiffness; light construction.

Telephone Buildings, Moving. 11,000-Ton Telephone Building Transposed Without Disturbing Normal Business. *Construction Methods*, vol. 13, no. 7, July 1931, pp. 32–35, 11 figs. Similar article previously indexed from *Eng. News-Rec.*, July 2, 1931.

Wind Bracing. Expert Testimony on Wind Design for Tall Building—III, Chord Deflections Control Web System Design, H. V. Spurr. *Eng. News-Rec.*, vol. 107, no. 3, July 16, 1931, p. 110. Discussion by E. A. Richardson, of paper previously indexed from issue of June 18, 1931.

CONCRETE

Admixtures, Hydraulic Lime. Hydraulic Lime in Concrete, G. W. Hutchinson. *Rock Products*, vol. 34, no. 13, June 20, 1931, pp. 54–55, 3 figs. Previously indexed from *Eng. News-Rec.*, June 11, 1931.

Aggregates, Weighing. Concrete Aggregate Weighing Devices. *Can. Engr.*, vol. 61, no. 3, July 21, 1931, pp. 19–20. Specification recommended for use with bin batcher and central mixing plant.

Concrete Aggregate Weighing Devices. *Can. Engr.*, vol. 61, no. 5, Aug. 4, 1931, pp. 18 and 62. Specification for weighing devices to be used with mixers of one-half cubic yard capacity or less.

Construction, Cold Weather. Frozen Concrete Used in Russian Buildings, A. M. Gunzburg. *Eng. News-Rec.*, vol. 107, no. 6, Aug. 6, 1931, p. 207. Experience with winter concrete construction in Ukraine since 1905; winter concrete is allowed to freeze before setting and is protected so that it will be kept in a frozen condition until spring.

Costs. Estimating Cost of Concrete Work—III, L. H. Allen. *Concrete*, vol. 39, no. 2, Aug. 1931, pp. 21–22. Removal of bar reinforcement; cost of placing steel; price differential on smaller sizes; finishing exposed surfaces; and cost of floor finish.

Mixing. Some Notes on Proportioning Concrete, H. V. Vogan. *Inst. Engrs. Australia—Journal*, vol. 3, no. 5, May 1931, pp. 170–171. Discussion by M. G. Dempster of paper previously indexed from issue of Jan. 1931.

Pavements, Black. Black Concrete Pavement Laid on Street in Residential Section, G. R. Hartley. *Eng. News-Rec.*, vol. 107, no. 3, July 16, 1931, pp. 98–99, 2 figs. Construction of black pavement on Glenwood Road, Englewood, N.J., by use of 8 lb. of iron oxide per sack of cement; pavement was designed for 1-in. top consisting of $1:1^{1}/_{2}:2$ mixture, using $^{1}/_{2}$-in. graded stone; strength tests.

Railroad Construction. The Use of Reinforced Concrete in Railway Work in India, R. Ram. *Indian Eng.*, vol. 89, nos. 23 and 24, June 6, 1931, pp. 496, and 498–501 and June 13, pp. 518–520. In the first article: Reinforced concrete may be used in preference to other materials for merely esthetic effects; for esthetic effect combined with structural economy and consequent economy in initial cost and for economy in maintenance of works, though there may or may not be economy in initial capital cost. In the second article: Use in construction of high-tension lines or telegraph posts; formulas for loads on poles; concrete railway ties; and line structures. (To be continued.)

Ready-Mixed, Plants. Central Concrete Mixing. *Roads and Road Construction*, vol. 9, no. 102, June 1, 1931, pp. 185–188, 9 figs. Description of two plants in England.

Waterproofing. Painted or Exposed Concrete Masonry, R. E. Copeland. *Concrete Products*, vol. 40, no. 7, July 1931, pp. 8–11, 6 figs. Methods of making walls weather-tight and water-tight.

CONSTRUCTION INDUSTRY

Construction Industry—Costs. Current Construction Unit Prices. *Eng. News-Rec.*, vol. 107, no. 3, July 16, 1931, pp. 118–119, 4 figs. Unit prices bid and a description of the following: vertical fiber brick pavement, Akron; Sunrise highway cross-over, Queens Borough, N.Y.; Lock and Dam 15, Mississippi River; dredging Manasquan River Channel, New Jersey; reinforced-concrete cover for two reservoirs.

Current Construction Unit Prices. *Eng. News-Rec.*, vol. 107, no. 5, July 30, 1931, pp. 196–197. Unit prices bid on laying 8 miles of 10 and 12-in. cast-iron pipes at Canajoharie, N.Y., on several miles of four types of steel pipe with 48, and 54-in. diameters, and on 24-in. cast-iron pipe for Cleveland, Ohio.

Water Works Management. How Payment Is Secured for Water Used in Construction Work. *Water Works and Sewerage*, vol. 78, no. 7, July 1931, pp. 189–190. Symposium on practice of several water companies and municipal water departments in Eastern and Western states.

DAMS

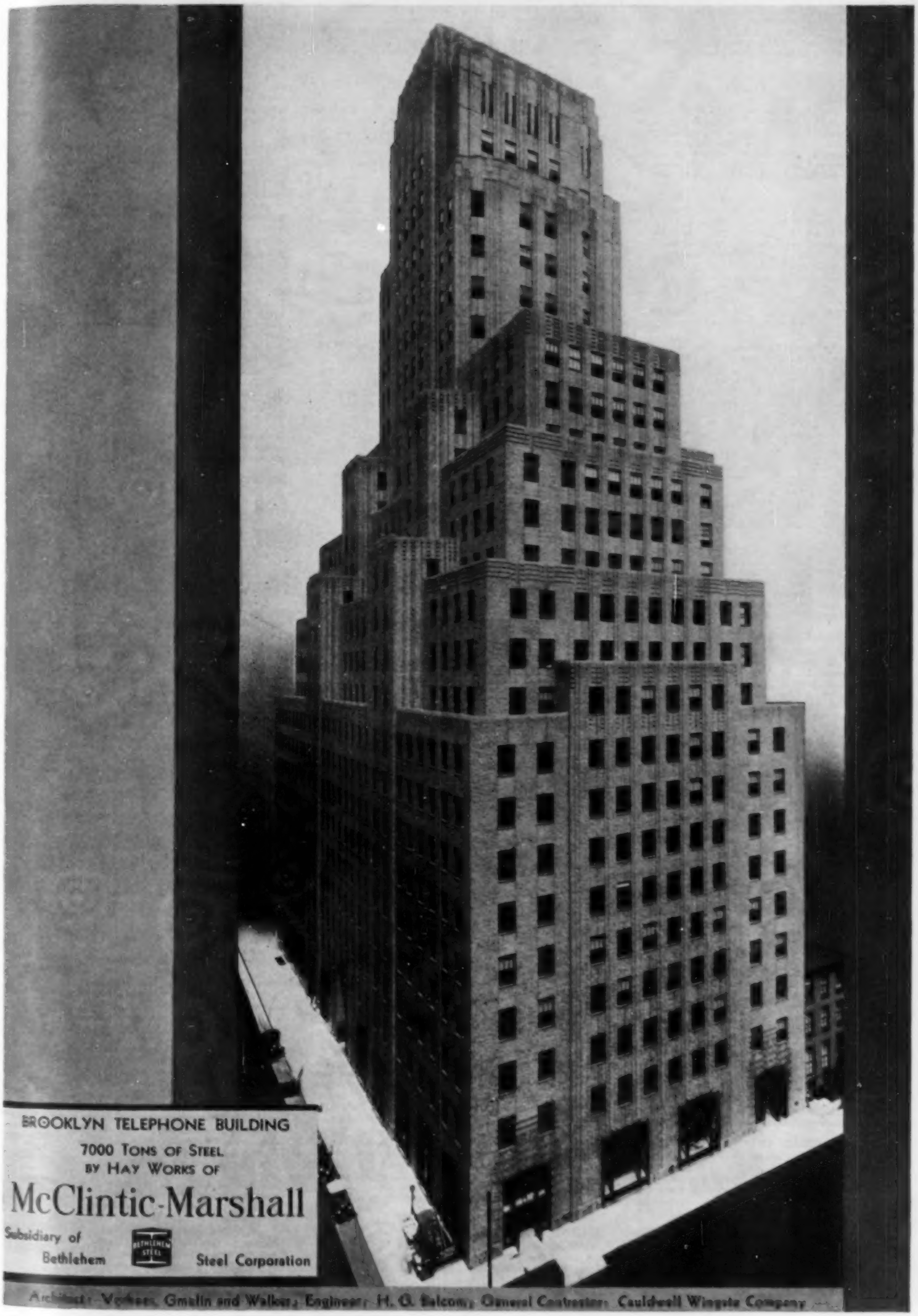
California. Three Types of Design Used in California Flood-Control Dam, R. G. Wadsworth. *Eng. News-Rec.*, vol. 107, no. 2, July 9, 1931, pp. 46–49, 5 figs. Variable-radius arch, straight and curved gravity sections, and earthfill employed in the 137-ft. Hogan Dam recently built by the City of Stockton, Calif., on the Calaveras River. Design of arch and abutment.

Concrete Arch, Deadwood, Idaho. Deadwood Dam Construction Work Controlled by 50-Mile Truck Haul, R. J. Newell. *Eng. News-Rec.*, vol. 107, no. 4, July 22, 1931, p. 144, 1 fig. Construction of concrete arch dam, 153 ft. high, for Boise irrigation project in Idaho.

Concrete, Egypt. The Nag Hammadi Barrage, Upper Egypt, A. R. Ellison. *Civil Eng.* (*Lond.*), vol. 26, no. 1, June 1931, pp. 19–20. Previously indexed from *Inst. Civil Engrs.—Minutes of Proc.*, Paper no. 4816, 1930–1931.

Concrete Gravity, Canal Zone. Madden Reservoir to Increase Water Supply of Panama Canal. *Eng. News-Rec.*, vol. 107, no. 5, July 30, 1931, pp. 162–164, 3 figs. Construction of reservoir on Chagres River in Panama to augment water supply of Panama Canal; main dam will be of concrete gravity type, 220 ft. high; several saddle dams will be of earth and gravel fill.

Construction, United States. Modern Dam Construction, C. M. Saville. *Surveyor*, vol. 80, no. 2058, July 3, 1931, pp. 5–6. Descriptions and typical illustrations of practice in the United States in the design and construction of dams. Before Inst. Water Engr.


BROOKLYN TELEPHONE BUILDING
7000 Tons of Steel
by Hay Works of
McClintic-Marshall
Subsidiary of
Bethlehem
BETHLEHEM STEEL
Steel Corporation
Architect: Voorhees, Gmelin and Walker; Engineer: H. G. Balcom; General Contractor: Cauldwell Wingate Company

SPILLWAYS, FLASHBOARDS. Blocking the Spillways of Dams Is Dangerous, H. K. Bell. *Eng. News-Rec.*, vol. 107, no. 2, July 9, 1931, p. 64. Attempts after last year's drought, to conserve water by flashboards are creating hazards.

FLOW OF FLUIDS

LIQUID METERS. The "Leinert" Liquid Meter. *Machy. Market*, no. 1601, July 10, 1931, p. 20, 3 figs. Meter will deal with uniform flow of fluid to be measured within plus or minus one-half of one per cent, independent of temperature changes; it consists of two tilting tanks, each containing predetermined weight of liquid, which tilt forward on frictionless knife edges or bearings and discharge without leakage or loss.

FOUNDATIONS

BRIDGES, STEEL TRESTLE, PILES. Long Life of Structural Steel Piles, R. C. Manning. *Can. Engr.*, vol. 61, no. 1, July 7, 1931, pp. 25–26, 5 figs. Highway structures near Chatham, Ont., built 30 years ago, with steel bearing piles still in good condition.

COLUMNS, FOOTINGS, DESIGN. Steel Slabs for Column Bases, G. C. Priester and C. H. Sandberg. *Eng. News-Rec.*, vol. 107, no. 6, Aug. 6, 1931, p. 224, 1 fig. Discussion by K. G. Merriam of paper previously indexed from issue of Mar. 19, 1931.

LANDSLIDES. Some Theoretical Considerations on Landslides, D. P. Krynine. *Eng. News-Rec.*, vol. 107, no. 3, July 16, 1931, p. 93, 6 figs. Analytic study of earth slips and stop pile action; results of author's experiments on behavior of pile under action of force perpendicular to its direction, begun in Moscow, Russia, and now proceeding at Yale University in cooperation with the Connecticut State Highway Department; piles and sheetpiles hold earth already in movement; they are driven at foot of slope and sometimes actually represent retaining walls.

OIL WELL DRILLING, DERRICKS. Special Concrete Foundation for Derricks on Quick Sand, J. C. Albright. *Oil Weekly*, vol. 62, no. 5, July 17, 1931, pp. 27–29, 4 figs. Practice developed in north end of Oklahoma City oil field.

SOILS, PHYSICS. The Dynamic Properties of Soil, M. L. Nichols. *Agric. Eng.*, vol. 12, no. 7, July 1931, pp. 259–264, 6 figs. Explanation of dynamic properties of soils by means of colloidal films; physics of film action in non-plastic and plastic soils; Atterberg plasticity constants; plasticity number.

HYDRAULIC ENGINEERING

HYDRAULIC LABORATORIES, VICKSBURG, MISS. Application of Model Research to Mississippi Flood Problems, H. D. Vogel. *Eng. News-Rec.*, vol. 107, no. 3, July 16, 1931, pp. 84–88, 7 figs. Description of plant of the U.S. Waterways Experiment Station at Vicksburg, Miss.; organization for experimental work; model studies of backwater, cut-offs, embankment overflow, and slackwater navigation dams.

HYDRAULIC STRUCTURES, CONSTRUCTION. Belt Conveyor Plants for Placing Dry Concrete, B. Widmann. *Eng. News-Rec.*, vol. 107, no. 6, Aug. 6, 1931, p. 216, 3 figs. Combination hoist tower and suspended belt conveyor plants employed successfully on large German dam and lock structures; twin tower plants used in constructing Hamburg quay wall.

HYDRO-ELECTRIC POWER PLANTS

ONTARIO. The Alexander Power Development on the Nipigon River, T. H. Hogg. *Hydro-Elec. Power Commission Ont.—Bul.*, vol. 18, no. 6, June 1931, pp. 201–207, 4 figs. Paper before Eng. Inst. Can., previously indexed from various sources.

PUMPING PLANTS, FLOATING. Lowering the Level of Mountain Lakes by Means of Centrifugal Pumps. *Water and Water Eng.*, vol. 33, no. 390, June 20, 1931, pp. 271–273, 274–276, 7 figs. Practical experience with the pumping of large quantities of water in various localities in Switzerland, Austria, and other countries, against heads of 100 to 150 ft.; with special reference to floating pumping stations; pumping for hydro-electric storage.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

RAILROAD TRACKS, EARTHQUAKE EFFECTS. Earthquakes in Burma and Their Effect on the Railway. *Ry. Engr.*, vol. 52, no. 818, July 1931, pp. 268–269, 4 figs. Details of damage, repairs, and new anti-earthquake construction.

INDUSTRIAL BUILDING

WIND PRESSURE. Wind Pressure on a Mill Building, H. L. Dryden and G. C. Hill. *Eng. News-Rec.*, vol. 107, no. 4, July 22, 1931, pp. 135–136, 7 figs. Previously indexed from *U.S. Bureau of Standards—Journal Research*, Apr. 1931.

INLAND WATERWAYS

RIVERS, IMPROVEMENT. Cuyahoga River to Be Widened at Bends. *Eng. News-Rec.*, vol. 07, no. 3, July 16, 1931, p. 99, 1 fig. Discussion of plans for straightening sharp bends of Cuyahoga River through the congested industrial valley region of Cleveland; the river is to be widened at bends and narrow points to pass ore ships 600 ft. long; the cost will approach $6,000,-000.

IRRIGATION

CANALS, CLEANING. Experience in Cleaning Irrigation Ditches by Machine, G. Ebner. *Eng. News-Rec.*, vol. 107, no. 5, July 20, 1931, p. 172, 1 fig. Cost of cleaning irrigation canals of Valier Irrigation Project in north-central Montana; 100 to 115 miles per year cleaned in a continuous operation, at a cost of less than $100 per mile.

INDIA. Irrigation Research Work in the Punjab, E. M. Taylor. *Engineer*, vol. 152, no. 3939, July 10, 1931, pp. 37–38. An account of the initiation of irrigation research, the stage to which it has advanced, and proposals for its development, given in Note on Proposed Development of Scientific Research in Irrigation Branch, Public Works Department, Punjab.

LAND RECLAMATION AND DRAINAGE

DRAINAGE, AUSTRALIA. The Busselton District Drainage Scheme, B. S. Crimp. *Inst. Engrs. Australia—Journal*, vol. 3, no. 5, May 1931, pp. 174–175. Discussion by L. R. East of paper previously indexed from issue of Dec. 1930.

RECLAMATION OF LAND. Reclamation of Land from the Sea. *Ferro-Concrete*, vol. 23, no. 1, July 1931, pp. 39–40. Two methods used on Isle of Ely for purpose of dock and harbor development; river draining; disposal of dredged and waste materials.

MATERIALS TESTING

APPLICATIONS. Testing Machines and Their Applications, P. G. Foster. *Machy. (Lond.)*, vol. 38, no. 978, July 9, 1931, pp. 467–470, 6 figs. The design and operating principles of the Buckton 100-ton machine for testing in tension, compression, shear, and torsion.

CABLES. Socketing Cable Test Specimens with High-Early-Strength Cement, W. K. Hatt. *Eng. News-Rec.*, vol. 107, no. 4, July 22, 1931, pp. 147–148, 1 fig. Description of method used in series of tension tests, carried on in the testing materials laboratory of Purdue University, on high-strength galvanized steel cables.

CASTINGS, HIGH TEMPERATURE. Some Considerations and Tests for Cast Materials for High-Temperature, High Pressure Service, L. W. Spring. *Iron and Steel Industry*, vol. 4, no. 10, July 1931, pp. 343–346, 2 figs. Paper before Inst. Brit. Foundrymen, previously indexed from Metal Industry (Lond.), June 19, 1931.

METALS, DEFORMATION. Strain-Hardening of Plastic Metals—I, E. V. Crane. *Iron Age*, vol. 128, no. 4, July 23, 1931, pp. 250–253, 6 figs. How plasticity is affected by repeated cold working; successive strain-hardening, followed by softening under annealing and thus working back and forth between a hard condition and soft, is carefully explained.

METALS FATIGUE. Crystallographic Investigation of Some Mechanical Properties of Metals, Y. Kidani. *Tokyo Imperial Univ., Faculty Eng.—Journal*, vol. 19, no. 7, May 1931, pp. 177–190, 14 figs., 4 supp. plates. Crystallographical study of fatigue of metals under alternating torsion; testing internal friction of fatigue specimens; micro-photographs illustrate structure of steel and copper specimens.

STEEL TESTING LABORATORIES, GERMANY. A New German Testing Laboratory, R. W. Miller. *Heat Treating and Forging*, vol. 17, no. 7, July 1931; pp. 665–667, 4 figs. Equipment of Sulzer Brothers central testing laboratory, for testing physical properties of metal and for determining structures.

STRUCTURAL STEEL, OXYACETYLENE CUTTING. Tests on Flame-Cut Wind Connections, O. E. Hovey. *Am. Soc.—Journal*, vol. 10, no. 6, June 1931, pp. 24–25, 3 figs. Previously indexed from *Eng. News-Rec.*, Apr. 30, 1931.

WALLS, CONCRETE. Stability of Concrete Masonry Walls Reported to A.S.T.M., F. E. Richart, P. M. Woodworth, and R. B. B. Moorman. *Concrete*, vol. 39, no. 2, Aug. 1931, pp. 15–16; see also *Concrete Products*, vol. 40, no. 7, July 1931, pp. 12–16, 2 figs. Tests of the action of wall panels under load, made at the University of Illinois; a part of the test was to determine whether the correction factor could be arrived at between tests of individual unit and full-sized wall.

WELDS. Some Tests of Gas Welded Structural Joints, H. H. Moss. *Am. Welding Soc.—Journal*, vol. 10, no. 5, May 1931, pp. 36–40, 10 figs. Tests on design approved by special building code committee of the City of Detroit; welds were investigated for direct shear, and for strength to resist turning force; dependability of welding procedure control.

MUNICIPAL ENGINEERING

SCIENCE OF ENGINEERING. City Engineering—Ancient and Modern, P. Johnston. *West City*, vol. 7, no. 7, July 1931, pp. 29–32 and 43, 11 figs. Evolution of a modern city showing how the science of municipal engineering has bettered the living conditions of the city dweller. Before Bureau Eng., Los Angeles.

CENTRAL AMERICA. Central American City Improves Sewers and Paving, R. C. Hardman. *Eng. News-Rec.*, vol. 107, no. 4, July 22, 1931, pp. 133–134, 4 figs. Review of recent municipal work in Puerto Limon, Costa Rica, which has a population of 12,000; the city changes its combined to a separate sewer system; paving troubles; heavy rainfall records.

PORTS AND MARITIME STRUCTURES

QUAY WALLS. Quay Wall Design and Construction, L. Beaudry. *Eng. Journal*, vol. 14, no. 7, July 1931, pp. 394–397, 10 figs. Various types of quay walls, with special reference to methods of construction suited to severe climatic conditions in eastern Canada; results of a number of tests of steel-sheet piling; methods of protection against corrosion.

RAILROADS, STATIONS, AND TERMINALS

MONTREAL. Steady Progress on C. N. R. Terminal Scheme in Montreal. *Contract Rec.*, vol. 45, no. 27, July 8, 1931, pp. 799–802, 10 figs. Expenditure of at least 50 million dollars will be made; sections of work now under way, or completed, are: demolition of buildings on terminal site or approaches, excavation of terminal site, construction of viaduct, crossing of Lachine Canal, modern fruit warehouse, two highway bridges, and bridge, 120 ft. wide.

TRAIN SHEDS, WRECKING. Demolition of Train Shed at South Station, Boston, J. C. Moses. *Eng. News-Rec.*, vol. 107, no. 5, July 30, 1931, pp. 177–178, 4 figs. Removal of huge train shed at Boston's South Station carried out without interfering with traffic on 28 tracks; traveling platforms, providing clearance beneath for train movements, were used; roofing material was stripped off by hand labor during night hours and loaded into cars on the tracks below. Before Am. Soc. Civil Engrs., previously indexed from *Eng. Soc. Boston—Journal*, Mar. 1931.

ROADS AND STREETS

JOINTS. Tools for Center-Joint Construction, W. E. Barker. *Eng. News-Rec.*, vol. 107, no. 4, July 22, 1931, pp. 145–146, 1 fig. Description of special methods and special tools developed by the Pennsylvania highway contractors, for straightening center-joints.

LAWS AND LEGISLATION. Excavations in Public Highways, N. Young. *Eng. News-Rec.*, vol. 107, no. 2, July 9, 1931, pp. 67–69. Rights and responsibilities of public authorities, private corporations, and contractors in excavating along roads and streets under both contract and day-labor work; municipal rights in streets.

MAINTENANCE AND REPAIR. Mud Jack Raises Street Pavement for 25c a Yard, W. E. Barker. *Eng. News-Rec.*, vol. 107, no. 6, Aug. 6, 1931, pp. 207–208, 1 fig. Mud jack developed in Iowa for raising concrete road slabs, as described in *Eng. News-Rec.*, Dec. 18, 1930, p. 979, recently used for raising about 9,000 sq. yd. of street pavement in Niles Center, Ill.; peak pressure required to break slab loose from subgrade; loam best material for mud mixture; raising from several holes reduces cracking.

MT. VERNON MEMORIAL. The Mount Vernon Memorial Highway. *Eng. News-Rec.*, vol. 107, no. 4, July 22, 1931, pp. 124–127, 8 figs. Design and construction of 15-mile, 4-lane, paved road of superhighway type being built from Washington, D.C., to Mt. Vernon, Va.; alignment and structures; typical grade and subgrade profiles; bituminous-concrete pavement on hydraulic fill and concrete base; reinforced-concrete pavement; types of grade separations and crossings.

PAVEMENTS, CONCRETE, EXPANSION JOINTS. Tests of Load Transmission Across Joints in Concrete Pavement, S. B. Slack. *Eng. News-Rec.*, vol. 107, no. 2, July 9, 1931, p. 53, 1 fig. V-plate center joint with dowels found effective; doweled bituminous transverse joints not effective; proposed slab-end reinforcement of transverse joints.

PRE-SHRINKING. South Carolina Highway Fills Pre-Shrunk by Pressure Jetting. *Eng. News-Rec.*, vol. 107, no. 3, July 16, 1931, pp. 88–89, 2 figs. Description of a method found equally useful for new fills and for old embankments, where subsurface shrinkage has been hidden by surface crusting or arching; contract prices on pressure jetting have ranged from $1^1/_2$ to 3 cents per cu. yd. of embankment.

ROAD CONSTRUCTION. Improving Highways by Stage Construction, B. E. Gray. *Contract Rec.*, vol. 45, no. 28, July 15, 1931, pp. 828–831, 3 figs. Practical methods to be followed in building up road surface in stages as traffic develops, using bituminous materials; correct method of design is to grade and drain proper roadway width, stabilize surface, and then improve it by additional treatments that gradually create high-class pavement.

ROAD SURFACE TREATMENT, UNITED STATES. Surface Treatment Methods. *Pub. Works*, vol. 62, no. 7, July 1931, pp. 17–18 and 48, 3 figs. As reported by county highway engineers.

Street Construction, United States. Road Surfacing in the United States, A. H. Redfield. *Engineering*, vol. 132, no. 3417, July 10, 1931, p. 59. Previously indexed from U.S. Bureau of Mines—Information Cir., no. 6431, May 1931.

Trends in the Construction of Street Pavements 1925–1929. *Pub. Works*, vol. 62, no. 7, July 1931, pp. 29–30 and 64–66. As determined by study of street paving in representative American cities, based on replies to questionnaire.

Swamps. Pile and Timber-Deck Bridging Covers Sunken Concrete Road, W. L. Craven. *Eng. News-Rec.*, vol. 107, no. 5, July 30, 1931, pp. 175–176, 3 figs. Construction by North Carolina State Highway Department of 2½ miles of specially designed pile and timber deck bridging to replace 16-ft. concrete road, built in 1923, that had become impassable for a considerable part of the year on account of settlement and subsequent flooding during high tide.

SANITARY ENGINEERING

Ontario. Progress in Sanitary Engineering, A. E. Berry. *Can. Engr.*, vol. 61, no. 5, Aug. 4, 1931, pp. 19–22, 53–54, and 57. Report covering activities of sanitary engineering division in Ontario during 1930.

SEWERAGE AND SEWAGE DISPOSAL

Edmonton, Alta. Sewage-Disposal Plant at Edmonton, Alta, R. J. Gibb. *Can. Engr.*, vol. 61, nos. 3 and 4, pp. 15–18, July 28, pp. 13–16 and 57, 10 figs. Treatment by submerged contact aerator, and digestion of sludge and screenings in partitioned tank.

Great Britain. The Works of the Birmingham, Tame, and Rea District Drainage Board, H. C. Whitehead. *Inst. Mun. and County Engrs.—Journal*, vol. 58, no. 1, July 7, 1931, pp. 68–88, 8 figs. Description of the sewage disposal system of a district occupying an area of 68,000 acres and having a population of 1,200,000; chemical analysis; settlement and disposal of solids in suspension; separation and disposal of sludge; treatment of sewage; purification in bacteria beds; purification by bio-flocculation process; sludge dewatering tanks; mechanical equipment; housing; cost of works.

Odor Control. Control of Sewage Disposal Plant Odors, J. R. Downes. *Can. Engr.*, vol. 61, no. 4, July 28, 1931, pp. 17–18. Causes and elimination of odors; discussion of local and migrating odors.

Providence, R. I. Providence Building 52,000,000-Gal. Activated-Sludge Plant. *Eng. News-Rec.*, vol. 107, no. 5, July 30, 1931, p. 181, 1 fig. Main features of plant and construction progress report.

Sewage Farms, Ohio. Using Sludge for Fertilizer at a Large Sewage Works Farm, C. C. Hommon. *Mun. Sanitation*, vol. 2, no. 7, July 1931, pp. 335 and 348. Satisfactory results create a demand for sludge from neighboring farms at Canton, Ohio.

Sewage, Gaging. Gaging Sewage Flow through a Continuous-Flow Dosing Tank, M. M. Cohn. *Water Works and Sewerage*, vol. 78, no. 7, July 1931, pp. 185–188, 7 figs. Schenectady gaging problem; calibration of dosing tanks; counting siphon doses.

Sewer Catch Basins. Increasing Stormwater Inlet Capacity by Improved Gutter Approaches, L. W. Armstrong, and G. S. Tapley. *Eng. News-Rec.*, vol. 107, no. 2, July 9, 1931, pp. 54–56, 6 figs. Report on experimental study by the Bureau of Engineering of Los Angeles, Calif., using street model which led to the definite design of depressions at inlets and the method of calculating capacity; capacities of side-opening inlets.

Sludge. Sludge Disposal at a Sewage Irrigation Farm, G. A. Mitchell. *Eng. News-Rec.*, vol. 107, no. 2, July 9, 1931, p. 57, 1 fig. Description of field disposal sludge-bearing sewage as practiced in Vineland, N.Y.

Small Sludge Bed More Efficient Under Lean-to Glass Inclosure, G. E. Wright. *Eng. News-Rec.*, vol. 107, no. 3, July 16, 1931, p. 102, 1 fig. Experience of Mamaroneck, N.Y., with lean-to type of glass inclosure, so designed as to allow as many sun rays as possible to strike surface of sludge; reflection was also utilized to limit.

Oxidation. Some Methods and Costs of Oxidizing Sewage, F. C. Vokes. *Surveyor*, vol. 80, no. 2059, July 10, 1931, pp. 36–37, 1 fig. Experiences of Birmingham, Tame, and Rea District Drainage Board; comparative costs of oxidizing sewage; bio-flocculation plants at Minworth. Before Conference Assn. Mgrs. Sewage Disposal Works.

STREET CLEANING AND REFUSE DISPOSAL

Incinerators, Great Britain. English Refuse Burner Produces Three Salable Products. *Eng. News-Rec.*, vol. 107, no. 5, July 30, 1931, pp. 165–166, 4 figs. Steam-producing refuse incinerator, recently installed in Hudersfield, Eng., has a capacity of 130 tons of calorific value, 5,000 B.t.u. per day of 18 hours, and includes 8 cells of Woodall-Duckham shaft-furnace type arranged in 4 units each with water-tube boiler and air preheater; high-pressure steam, hard graded clinker, and magnetically removed metals are sold; only dust dumped.

STRUCTURAL ENGINEERING

Concrete Design, Charts. Short-Cuts in Structural Design—IV, J. R. Griffith. *Concrete*, vol. 39, no. 2, Aug. 1931, pp. 37–39, 3 figs. Chart giving area moment provides quick solution for design of column footing when column load, size of column, and size of footing are known.

Floors, Concrete Slabs. Standardized Metal Unit Forms in Floor Slab Construction, B. R. Wiltscheck. *Concrete*, vol. 39, no. 2, Aug. 1931, pp. 32–35, 2 figs. Building floor slabs with form units used on foundation walls; bar joist supports leave clear working space below; assembly of standard units.

Light-Weight. Recent Developments in Light-Weight Floor and Roof Construction, B. S. Brown. *Boston Soc. Civil Engrs.—Journal*, vol. 18, no. 6, June 1931, pp. 195–224, 19 figs. Recent developments in secondary members for floors and roofs, such as: steel joists, junior beams, built-up joists, and battledeck floors; light-weight slabs or deckings of gypsum, haydite, aerocrete, and portete. Bibliography.

Viaducts, Concrete. Steel Bracing in Concrete Viaduct for Longitudinal Forces. *Eng. News-Rec.*, vol. 107, no. 2, July 9, 1931, pp. 61–62, 3 figs. Steep grade and foundation conditions of the complicated railway grade separation at Canal and 16th streets, Chicago, required unusual bracing to resist stresses caused by passing trains; steel bracing joined to concrete column through embedded gusset plates with angle-frame anchors.

SURVEYING

Mines and Mining, Maps. Mine Maps: Their Preparation, Correlation, and Maintenance, D. C. Gilbert. *Eng. and Min. Journal*, vol. 132, no. 1, July 13, 1931, pp. 18–20, 1 fig. Outline of factors influencing the adoption of a system of mining maps and records; an efficient and intelligent control of underground operations depends largely on graphical records that show geologic data, as well as the status of extraction and development operations.

TRAFFIC CONTROL

London. Oxford Street Traffic Control. *Elec. Times*, vol. 80, no. 2074, July 23, 1931, pp. 121–123, 6 figs. Description of the largest system of synchronized traffic control in Great Britain, together with a timing chart of traffic movement.

TUNNELS

Railroad, Quebec. Wolfe's Cove Branch Line and Tunnel, Canadian Pacific Railway, D. Hillman. *Can. Ry. and Mar. World*, no. 401, July 1931, pp. 423–426, 5 figs. Branch railway from Wolfe's Cove to Quebec; construction of tunnel 1 mile long and 16 ft. wide with a 22½-ft. clearance; materials used and construction operations.

Ventilation. Ventilation During Driving of New York's 20-Mile Water Tunnel, C. F. Kelley and I. R. Loss. *Eng. News Rec.*, vol. 107, no. 2, July 9, 1931, pp. 58–59, 7 figs. Design of ventilating plant for construction of New York City's water tunnel between Yonkers and Brooklyn; pressure drop in relation to pipe size; Kilowatt input per blower; blower cost in relation to pipe diameter; characteristics of blower set.

WATER PIPE LINES

Aqueducts. Los Angeles to Tap Colorado River with 265-Mile Aqueduct, J. L. Spring. *Compressed Air Mag.*, vol. 36, no. 8, Aug. 1931, pp. 3552–3556, 10 figs. Preliminary work on metropolitan aqueduct.

Colorado River. The Colorado River Aqueduct, J. Hinds. *Water Works and Sewerage*, vol. 78, no. 6, June 1931, pp. 157–160, 4 figs. An outline of the plan for making a portion of the water of the Colorado River, conserved by Hoover Dam, available to Los Angeles and her sister cities of the Southwest; necessity for a pumping project; sources of power for pumping.

Corrosion. Corrosion Reduction with Lime Treatment, E. S. Hopkins. *Water Works and Sewerage*, vol. 78, no. 7, July 1931, pp. 191–192, 4 figs. Experience of Baltimore Water Works; cost and benefits of lime treatment; hydrogen-ion concentration of water as delivered to city; ratio of *Fe* to *Ca* in scale.

Joints, Testing. Lateral Strength of Bell-and-Spigot Joints. *Eng. News-Rec.*, vol. 107, no. 4, July 23, 1931, p. 139. Results of a series of tests conducted at Ohio State University; tests included only bell-and-spigot poured joints of soft lead, some calked by hand, others with pneumatic hammer; materials to be investigated include alloy lead, portland cement, and sulphur compounds.

WATER PUMPING PLANTS

Practical Points in the Operation of Town Water-Works Pumps, C. E. Greene. *New England Water Works Assn.—Journal*, vol. 45, no. 2, June 1931, pp. 168–177, 4 figs. Practical points in the operation and control of electric motor-driven centrifugal pumps; development of automatic electric features.

WATER TREATMENT

Chlorination. Recent Developments in Chlorination, F. D. West. *New England Water Works Assn.—Journal*, vol. 45, no. 2, June 1931, pp. 136–141 and (discussion) 142–143. Review of progress since 1909. Bibliography.

Chlorination, Prechlorination. Prechlorination at Dayton, Ohio, Sewage Works. *Water Works and Sewerage*, vol. 78, no. 6, June 1931, pp. 173–175. Sewage chlorination in Germany and America; description of sewage treatment works and chlorination plant for flow of 26 m.g.d. Bibliography.

A Retrospection of Chlorination—II, Chlorination of Water, M. M. Cohn. *Mun. Sanitation*, vol. 2, no. 7, July 1931, pp. 333–335, 3 figs. Rôle of chlorination; sterilization of water; taste and odor control.

Color Removal. Color Removal in Coast Water Supplies, P. F. Bovard and K. Shibley. *West. City*, vol. 7, no. 7, July 1931, pp. 24–25. Streams vary widely and seasonally in color content; experience with activated carbons, oxidizing agents, and ferric chloride; how Marshfield's highly colored water is clarified. Before Am. Water Works Assn.

Manganese Removal. Manganese in Water—Its Occurrence and Removal, R. S. Weston. *Water Works and Sewerage*, vol. 78, no. 7, July 1931, pp. 196–198. Occurrence of manganese; manganese in the Wanaque Reservoir, in industry, and in pipes; demanganization

North America. Modern Aspects of Water Purification, E. S. Chase. *Surveyor*, vol. 80, no. 2058, July 3, 1931, pp. 3–4. Present state of the art of water purification in North America. Before Inst. Water Engrs.

Taste and Odor Removal. Tastes and Odors in Small Water Supply Removed by Ammonia, J. E. Lyles. *Water Works Eng.*, vol. 84, no. 14, July 15, 1931, pp. 1003–1004 and 1045, 1 fig. Data on successful experiments in removal of tastes and odors, through use of ammonia and chlorine as sterilizing agents, in water supply of Tampa, Fla.

Water Bacteriology. How Bacteria Are Killed by Disinfectants, J. R. Baylis. *Water Works and Sewerage*, vol. 78, no. 7, July 1931, pp. 193–195. Outline of the theory recently developed by W. D. Bancroft and G. H. Richter; narcotics and disinfectants produce coagulation of cell colloids; chemical balance in living cells probably very delicate; many compounds produce coagulation of cell colloids; how long does it take to kill bacteria?

Water Filtration, Sand. An Analysis of the Characteristics of Filter Sand, J. W. Armstrong. *Water Works Eng.*, vol. 84, no. 14, July 15, 1931, pp. 1009–1010 and 1026, 3 figs. Tests conducted in Baltimore, Md.; action in fine and in coarse-grained filters. Before Am. Water Works Assn.

WATER WORKS ENGINEERING

Albany, N.Y. The New Gravity Water-Supply System of Albany, N.Y., R. E. Horton and B. L. Smith. *New England Water Works Assn.—Journal*, vol. 45, no. 2, June 1931, pp. 89–135, 11 figs. History of Albany Water Works; description of Hannacrois-Catskill Project, which is to be developed in three stages, giving total ultimate yield of 69 m.g.d. at cost of nearly $30,000,000.

Boulder City, Nev. The Water System for Boulder City, B. Lowther. *West. City*, vol. 7, no. 7, July 1931, pp. 13–16, 7 figs. Water to be pumped from Colorado River and lifted 2,750 ft.; pumps, of centrifugal type, with lift of about 110 ft. will discharge into pre-sedimentation tank, where heavy particles of sand and silt will be removed; purification works; lime and soda ash treatment is designed to reduce hardness of water; 4 rapid-sand filter units receive softened and coagulated water for final treatment; sewage and garbage disposal.

Tanks, Gaging. How to Determine Capacity of Cylindrical Tanks. *West. City*, vol. 7, no. 7, July 1931, pp. 16–17. Chart for determination of capacity of tanks of circular cross section and constant diameter, in terms of barrels of 42 gal., as used in oil business, or in terms of gallons.

Water Works. Pacific Northwest Section, A. W. W. A. *West. Construction News*, vol. 6, no. 13, July 10, 1931, pp. 351–356, 3 figs. Account of the 4th annual meeting at Vancouver, B.C., May 14–16, with round-table discussions; papers on water supply of Vancouver, water rates, purification, color removal, and hydrology of Oregon; inspection trips.

Water Works Management. Items in the Operation of New York City's Water-Supply System of Interest to the Superintendent, W. W. Brush. *New England Water Works Assn.—Journal*, vol. 45, no. 2, June 1931, pp. 181–187, 1 fig. Previously indexed from *Water Works Eng.*, Apr. 22, 1931.

Water Wells, Tacoma, Wash. Well Development for the City of Tacoma, W. A. Kunigk. *West. City*, vol. 7, no. 7, July 1931, pp. 21–23, 2 figs. Water Division augments gravity supply with 4 new wells having a daily production of approximately 20,000,000 gal.